1901-02 to 1904-05

GENERAL REPORT

SURVEY OF INDIA

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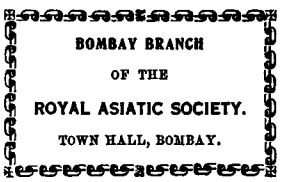

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COLONEL W. LAMBTON, F.R.S.

Originator and first Superintendent of the Great Trigonometrical Survey

1800—23.

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GENERAL REPORT

SURVEY OF INDIA

1901-02.

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GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1901-1902. to 1904-5.

PREPARED UNDER THE DIRECTION OF

COLONEL ST. G. C. GORE, C.S.I., R.E.,

SURVEYOR-GENERAL OF INDIA.

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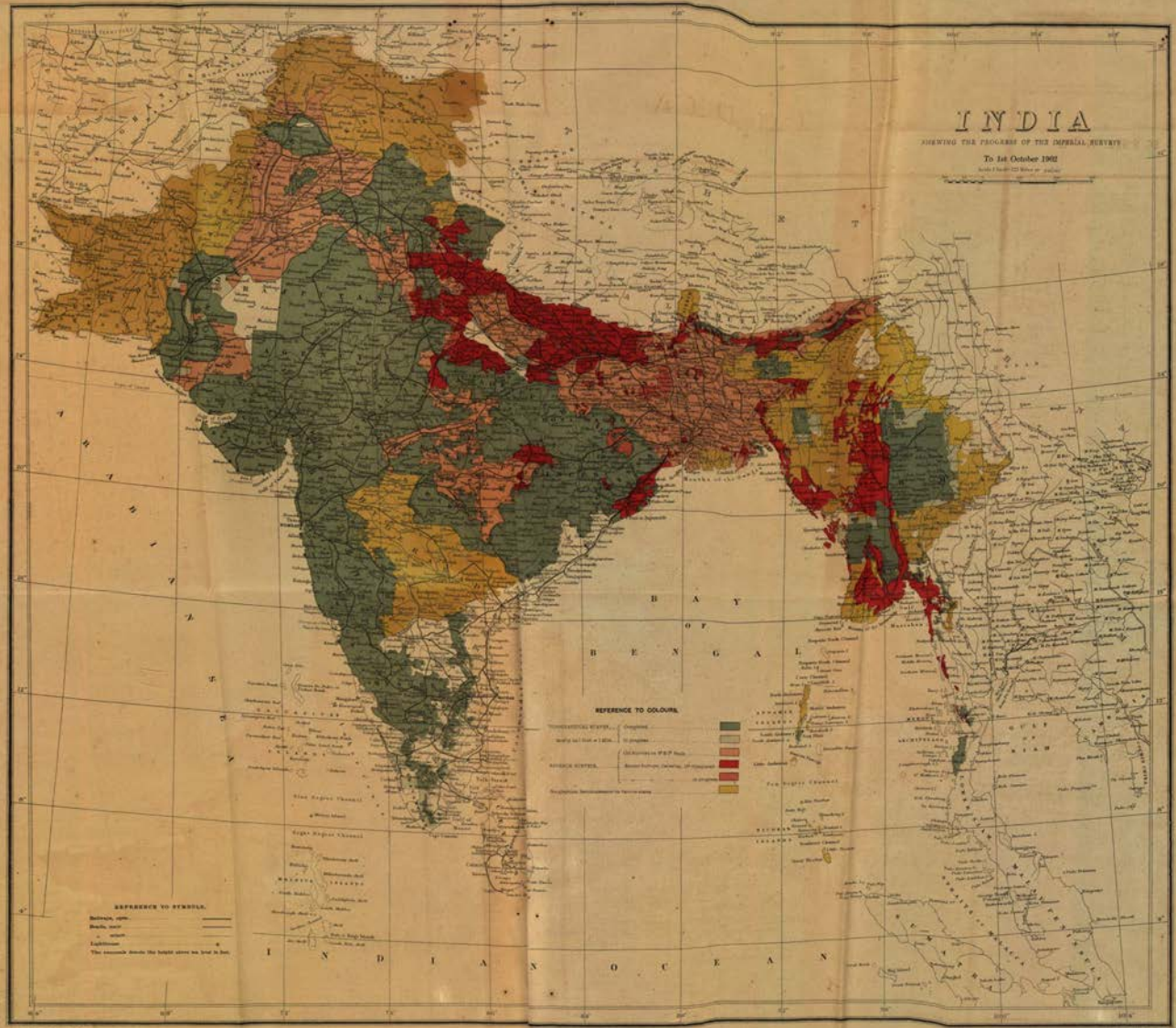

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GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1901-1902.

PART I.

SUMMARY.

ADMINISTRATION.

The operations of the department that are now reported on are for the survey year ending 30th September 1902.

2. Colonel St. G. C. Gore, R.E., Surveyor-General, directed the general administration of the department and also superintended the Topographical Branch up to 31st January 1902, when he proceeded on combined leave and Major F. B. Longe, R.E., was appointed to officiate as Surveyor-General. Colonel Gore returned from leave and resumed charge of his office on the 29th September 1902.

On account of Colonel Gore's and Colonel Hobday's absence there were a number of administrative changes.

The office of the Deputy Surveyor-General in charge of the Revenue Branch was held by Major Longe, R.E., up to 31st January, and on his appointment as Officiating Surveyor-General, Major S. G. Burrard, R.E., held charge of this Branch from 1st February to 30th April; when this officer also proceeded on combined leave and Major W. J. Bythell, R.E., was appointed to officiate as Deputy Surveyor-General from 1st May to 28th September. Major Longe reverted to his post of Officiating Deputy Surveyor-General on the 29th September.

The office of the Superintendent, Trigonometrical Branch, was held by Major S. G. Burrard, R.E., up to 31st January and thereafter by Mr. J. Eccles, M.A., up to the end of the year.

Major R. T. Crichton, I.A., and Captain W. M. Coldstream, R.E., held the offices of the Superintendents, Provincial Surveys, Bengal and United Provinces, respectively.

Major P. J. Gordon, I.A., held charge of Forest Surveys during the year. The Governments of Madras and Bombay have accepted the proposals of the Government of India that the terms of Government Resolution (Department of Revenue and Agriculture) No. 7-F., dated 25th April 1901, shall also be applicable to forest survey parties working in these Presidencies. The details of this arrangement are now under consideration, but as a preliminary measure Major Gordon was placed in administrative charge of Nos. 9 and 19 Parties (Madras Forests), and of No. 17 Party (Bombay Forests) from the 1st August 1902.

Inspection Tours of the Administrative Officers.

3. Major Longe, R.E., Officiating Surveyor-General, left Calcutta on the 15th April and proceeded to Dehra and Mussooree, inspecting the Trigonometrical Branch Office, the Forest Survey Office and that of No. 20 Party, at

the former place and the offices of Nos. 14 and 15 Parties, the North-West Frontier Drawing Office and the Kashmír Detachment at Mussooree.

At Dehra he was especially occupied with the question of the transfer of the Forest Survey Branch to the Survey of India, of the transfer of the recess quarters of No. 20 Party to Bangalore and the construction of a new office for the Forest Surveys in the compound of the Trigonometrical Branch Office. He left Mussooree on the 30th and reached Simla on the 1st May. During his stay at Simla he, on several occasions, visited the recess office of No. 18 Party. On the 17th July he left Simla and proceeded to Dehra, when he again inspected the Trigonometrical Branch Office, the Forest Survey Office and that of No. 20 Party and drew up a scheme for the future arrangements involved by the transfer of the Forest Survey to the Survey of India.

Proceeding to Mussooree he inspected the office of No. 15 Party and the Drawing Office afresh, as well as the Persian Detachment and No. 14 Party. He returned to Calcutta on the 11th August and proceeded to Bangalore on the 25th idem. At Bangalore he inspected the offices of Nos. 3, 9 and 19, 10, 11 and 21 Parties and the Bangalore Drawing Office. On the 6th September he proceeded to Poona when he, in company with the Superintendent, Forest Surveys, inspected the office of No. 17 Party (Bombay Forests). He returned to Calcutta on the 12th idem. Almost every party was visited during the year by either the Surveyor-General or the Deputy Surveyor-General, many of them by both.

A visit to Assam had been planned for the Deputy Surveyor-General, but unfortunately at the only time it was possible it was found that the Superintendent, Provincial Surveys, had been granted three months' privilege leave, and consequently the question to be gone into in connection with the work in that Province could not have been discussed and the visit had to be abandoned.

4. Major Longe, R.E., Officiating Deputy Surveyor-General, in charge Revenue Branch, left Mussooree on October 27th and proceeded to Allahabad, and on 10th November inspected the camp office of No. 14 Party, which was just starting work in this district on its transfer from Lushai, at that place. The traverse work was already started and, beyond temporary difficulties connected with the transport of the mark stones across the Ganges, was progressing favourably. Thence he proceeded to Jubbulpore and inspected the office of the Central Provinces Detachment and the Drawing Office. He arrived in Calcutta on the 13th idem. On the 24th January 1902 he proceeded to Sihora road and inspected in the field the work of the Central Provinces Detachment, revising the standard maps compiled from reduction of the *patwaris'* cadastral maps. He returned to Calcutta on the 31st January and took over charge of the office of Surveyor-General, on 1st February.

Major Burrard, R.E., Officiating Deputy Surveyor-General, proceeded on a tour of inspection to Burma on the 11th February and after having inspected the field work of Nos. 3 and 7 Parties he returned to Calcutta on the 27th March 1902. The main object of this tour was to go thoroughly into the question of the continuance of the survey on the 1-inch scale in certain districts, to settle with the local authorities what areas were of greater and what of less importance and generally to get an idea of the future employment of the parties working there. A separate report is being submitted to Government on the subject, but generally it was agreed that no area should be excluded from survey on this scale, the proper expansion of the country as regards trade, etc., depending largely on the possession of maps on which roads, telegraphic lines, etc., can be roughly laid out.

Major Bythell, R.E., took over charge of the office of Deputy Surveyor-General from Major Burrard, R.E., on the 1st May. As there were several questions regarding the work of No. 18 Party to be discussed with the Surveyor-General, Major Bythell, with the sanction of the Government of India took over charge by telegram in Simla and remained there till the middle of May. He left Calcutta on the 9th June for Mussooree and inspected the offices of No. 14 Party and the Bengal Traverse Detachment, and also visited the office of No. 15 Party, returning to Calcutta on the 21st. He proceeded to Jubbulpore on the 1st August, and inspected the office of the Central Provinces Detachment, and returned to Calcutta on the 7th. On the 25th August he again left Calcutta for Bangalore, where he inspected the office of No. 3 Party and

visited those of Nos. 9 and 19, the Bangalore Drawing Office and Nos. 11 and 21 and returned to Calcutta on the 7th September. Whilst in Calcutta he twice inspected the work of the Bengal Drawing Office.

5. Major Burrard, R.E., Superintendent, Trigonometrical Surveys, inspected No. 25 Party (Tidal and Levelling) at Dehra Dún in October 1901. Mr. Eccles, Officiating Superintendent, Trigonometrical Surveys, visited Mussooree in June 1902, and inspected Nos. 22 and 23 Parties (Astronomical) and No. 26 Party (Magnetic). He also visited Nos. 14 and 15 Parties and the North-West Frontier Drawing Office. In September he inspected No. 24 Party (Triangulation) at Mussooree and No. 12 Party (Sind) at Kurrachee. During the year he visited the Training School at least once a month and No. 25 Party (Tidal and Levelling) from time to time.

6. Major Gordon inspected in the field the detachments of the Forest Surveys working in the Central Provinces, Bengal and Burma, and No. 20 Party in the field in Burma and also during recess at Dehra Dún. He accompanied the Officiating Surveyor-General to Bangalore and Poona, where he inspected the Forest Survey Parties recessing there. In June he visited Simla to confer with the Officiating Surveyor-General and the Inspector General of Forests regarding the reorganization of the Forest Survey Branch.

FIELD PARTIES.

7. Field operations were carried on by three double and fifteen ordinary parties and two detachments; of these one was employed on trigonometrical, one double and six ordinary parties on topographical surveys, one double and two ordinary parties on forest surveys, one double and two ordinary parties on cadastral surveys, two detachments on traverse surveys and four parties on scientific operations.

8. The operations of the Forest Survey Branch, which are under the administration of the Superintendent of Forest Surveys, are fully reported on in the Forest Survey Report and are therefore only briefly mentioned here.

The surveys carried on by local agency in the United Provinces of Agra and Oudh, which are under the general supervision of the Deputy Surveyor-General, have also been included in this report under the head of cadastral surveys.

9. In the following statement the whole of the operations are grouped according to the nature of the work on which the parties are employed :—

Statement of Survey Operations and Parties.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey. Inch. Mile.	Administrative Superintendent.
	Trigonometrical.				
24	India Triangulation	21	Lieutenant H. Wood, R.E. „ H. M. Cowie, R.E.	...	Supdt., Trig.
	Topographical.				
3	Lower Burma	21	Mr. E. Litchfield	2 = 1 1 = 1	D. S. G., Rev.
10	Upper Burma	24	Captain F. W. Pirrie, I.A.	1 = 1	D. S. G., Topo.
11 & 21	Ditto	25	Lieutenant A. A. McHarg, R.E. Mr. P. J. W. Doran	1 = 1	Ditto.
12	Sind	26	„ C. F. Erskine	2 = 1 1 = 1	Supdt., Trig.
14	United Provinces	27	„ R. B. Smart	2 = 1	D. S. G., Rev.
15	North-West Frontier	29	Captain C. W. H. Symonds, I.A. Mr. E. A. Wainright	Various	D. S. G., Topo.
18	Punjab	30	Lieutenant A. A. McHarg, R.E. Major W. J. Bythell, R.E. Captain G. A. Beazeley, R.E.	2 = 1 1 = 1	D. S. G., Rev.

Statement of Survey Operations and Parties—concld.

No. of Party.	Nature and *locale* of operations.	Page in this report.	Executive Officers.	Scale of Survey. Inch. Mile.	Administrative Superintendent.
	Forest.				
9 & 10	Madras Presidency	32	Mr. H. Todd	4 = 1	D. S. G., Rev.
17	Bombay Presidency	34	Mr. B. G. Gilbert-Cooper „ S. F. Norman	8 = 1 4 = 1	D. S. G., Topo.
20	Burma	35	Captain A. H. B. Heme, R.E.	4 = 1	Supdt., Forest Surveys.
	Bengal Central Provinces. Burma Punjab	37	Major P. J. Gordon, I.A.	4 = 1	Ditto.
	Cadastral.				
2 & 8	United Provinces	40	Captain W. M. Coldstream, R.E.	16 = 1	D. S. G., Rev.
4	Bengal	42	Major R. T. Crichton, I.A.	16 = 1	Ditto.
7	Burma	45	Mr. J. Connor Major G. B. Hodgson, I.A. Lieutenant C. P. Gunter, R.E.	16 = 1	Ditto.
	Traverse.				
	Central Provinces	48	Mr. R. C. D. Ewing		Ditto.
	Assam	50	„ T. Shaw		Ditto.
	Geodetic.				
22 23	India	52	Lieutenant H. M. Cowie, R.E		Supdt., Trig.
	Tidal & Levelling.				
25	India	53	Captain H. L. Crosthwait, R.E. Mr. E. J. Connor		Ditto.
	Magnetic.				
26	India	54	Captain H. A. D. Fraser, R.E.		Ditto.

OUTTURN.

10. The total outturn of detail survey during the year amounts to 104,794 square miles which includes 68,162 square miles of reconnaissance surveys on the ½-inch and smaller scales. The area surveyed during the previous year amounted to 48,106 square miles, and the increase is due to large areas of reconnaissance surveys on the North-West and North-East frontiers. The total area of rigorous surveys on all scales is 36,632 square miles, which is 5,526 square miles in excess of that done last year. The total area triangulated is 99,496 square miles, which includes 83,790 square miles triangulated in connection with reconnaissance surveys. The total area traversed for cadastral purpose is 5,424 square miles, *viz.*, 181 square miles in the United Provinces of Agra and Oudh, 4,171 square miles in Bengal and 1,072 square miles in Burma.

TRIGONOMETRICAL SURVEYS.

11. The Triangulation party (No. 24) was employed in completing the Manipur Minor Meridional Series, extending it southwards over the Kyaukpyu Yomás, in the neighbourhood of Mount Victoria. The work was completed and a very satisfactory junction effected with two stations of the Burma Coast series.

This series of triangulation will be a very valuable one in aiding the extension of topographical and other surveys, and already it has proved of the utmost use to the Forest Surveys in the Chindwin valley.

TOPOGRAPHICAL SURVEYS.

12. Some changes have been made during the year under report in the composition and the *locale* of operations of the Topographical Survey parties. In Burma the two parties, Nos. 11 and 21, which were working independently in the Shan States have been amalgamated into one party charged with the completion of the work in these States. No. 14 Party has been transferred from Lushai to the United Provinces of Agra and Oudh, and No. 18 Party from the Himalayas to the plains of the Punjab.

13. The work of No. 3 Party, which as before is employed in Lower Burma, consists mainly of surveying the blanks omitted from the cadastral surveys and so filling up and completing the maps, which otherwise would be fragmentary and useless. In addition the party undertook the revision and completion of the topographical detail obtained from the reductions of the cadastral sheets. Work was carried on in the Pegu, Hanthawaddy, Toungoo, Thayetmyo and Prome districts. The outturn for the season is a much more satisfactory one than that of the previous year, 1,905 square miles of detail survey having been completed on the 1-inch scale and 350 square miles on the 2-inch scale, while the revision of the sheets prepared from cadastral reductions has been carried on over an area of 1,048 square miles. In addition the usual triangulation in advance has been carried out.

14. The work of No. 10 Party is confined to the west of Longitude 96° 30′ and consisted entirely of revising and adding to the maps produced by reducing the cadastral sheets. Such maps without revision are in many parts of Burma quite meaningless and useless owing to the omission of hills and other topographical detail. The large area of 4,100 square miles was thus completed and revised at a cost per square mile considerably less than that of last year.

The large scale maps of the town of Maymyo, which is rapidly extending, were revised and brought up to date.

15. The two parties, Nos. 11 and 21, which worked independently last year, were this year amalgamated and considerably reduced. The combined party continued operations in the Southern Shan States, the ground surveyed on the 1-inch scale lying along the west of the Salween river. The area thus completed amounted to 2,663 square miles. In addition to this some surveyors worked across the Salween to the eastwards, filling up and amending the older reconnaissance survey sheets which had been surveyed on the $\frac{1}{4}$-inch scale.

16. The whole question as to how far topographical surveys should be carried in Burma has been under discussion during the year and final orders have not yet been issued on the subject. The $\frac{1}{4}$-inch reconnaissance survey which was commenced as soon as Upper Burma was occupied is, except in those cultivated districts in which cadastral operations have been carried on and those areas which have been already mapped on the 1-inch scale, the only guide to the topography of the country. Like all such reconnaissance surveys, it varies both in accuracy and fulness of detail according to the facilities which the surveyors obtained at the moment for traversing the country and the time available for the work. In its present state it certainly is not good or complete enough to suffice for military purposes even if the scale were sufficiently large, which is doubtful, while the scale is unquestionably too small to render the maps of full value in assisting the Public Works and the Civil Administration in opening out the country. It is very essential if new roads, canals and such aids to the development of a country are to be laid out with economy and to the best advantage that the authorities concerned should be in possession of a sufficiently good map of the country so as to prevent costly mistakes being made. It is generally conceded that this want can only be met by a good topographical map on a scale of not less than 1 inch=1 mile. Burma is being rapidly opened up and the demand for such maps is very great. There are, however, undoubtedly certain areas which from their present remoteness or inaccessibility are unlikely to be exploited for some considerable time, and the mapping of such parts may well be postponed for future consideration.

17. The survey of Sind was continued by No. 12 Party. British territory was as before surveyed on the 2-inch scale, an area of 1,597 square miles being completed, while the more desert portions of the Khairpur State were mapped on the reduced scale of $\frac{1}{2}$ inch=1 mile; of this latter the large area of 4,556

square miles was surveyed. The usual triangulation and traverse in advance was also carried out.

18. The work in the Lushai hills having been closed, No. 14 Party, considerably strengthened, was transferred to the United Provinces in order to take up the topographical survey of Allahabad and other districts of which no maps existed. This being the first season in the new ground, the work consisted mainly of traversing in preparation for future detail survey. One thousand nine hundred and eighty-eight square miles were thus prepared and a commencement of the detail survey was made, a small area of 203 square miles having been mapped.

19. No. 15 Party has been employed as in previous years on work required by the Military Authorities. In addition to the continuation of the work in Sind and Kashmir the party commenced the survey of the cantonments in the Bengal Command, eight cantonments and bazars having been surveyed during the season. The outturn of work in Kashmir amounted to 2,787 square miles while 1,696 square miles were completed in Sind. A large area of frontier reconnaissance was also completed.

20. No. 18 Party having completed its programme in the Kángra district commenced work in the plains of the Punjab, its main work being to utilize the large scale *patwari* maps of the Punjab, and from them compile and complete, by work in the field, a topographical map. The village trijunctions of the districts concerned have all been fixed by a professional traverse, so the means are to hand of combining the reduced *patwari* maps which then only require checking and completing in the field, the main points requiring supplement being the river banks and village sites. Three thousand square miles of the Montgomery and Lahore districts were thus mapped. A few hundred square miles of country in the Simla Hill States which remained for completion was also surveyed. In addition to this topographical work a portion of the party was employed in carrying on riverain traverses for the Local Government, in order to give the means of fixing once for all the riverain boundaries of the Punjab districts. The Simla Estate boundary survey was continued during the open season, and if no further extensions of it are asked for should be shortly complete.

21. The total outturn for the year under the head of topographical survey on various scales, from 1-inch upwards, amounted to 8,801 square miles of new survey and 10,084 square miles of topographical revision survey.

The total is made up as follows:—

11,667	square	miles	surveyed	and	revised	on	the	1-inch	scale.
7,141	"	"	"	"	"	"	2	"	"
23	"	"	"	on			4	"	"
54	"	"	"	"			6	"	"

FOREST SURVEYS.

22. The special surveys of Government forests were, as in previous years, carried out by the detachments of the Forest Surveys, Bengal Presidency, and by No. 20 Party under the administration of the Superintendent, Forest Surveys, and the control of the Inspector General of Forests, and by Nos. 9 and 19 Parties in Madras and No. 17 Party in Bombay working under the administrative charge of the Deputy Surveyor-General (Revenue) and the Deputy Surveyor-General (Topo.) respectively and under the control of the Surveyor-General. The scheme for bringing all Forest Surveys in India under similar rules under the administrative charge of the Superintendent of Forest Surveys, and under the control of the Surveyor-General, is well advanced.

23. In Bombay surveys were carried on in the Northern, Central and Southern Circles. The outturn was, in addition to triangulation and traversing, 607 square miles of detail survey on the 4-inch scale and 161 on the 8-inch. It having been decided to confine 16-inch surveys to the more valuable *babul* reserves situated below flood level it was not found necessary to survey any forest areas on this scale during the year. The cost-rates were R63 per square mile for 4-inch detail survey and R136 for 8-inch. The cost-rate of the 4-inch survey is practically the same as for the previous year while that of the 8-inch survey is greater. In this party the charges for supervision of late years have varied greatly and differences in cost-rates are generally attributable more to this circumstance than to any other cause.

24. In Madras Nos. 9 and 19 Parties continued the survey of forests in Kurnool, Cuddapah and South Canara on the 4-inch scale. In addition to the Survey of Government forests a detachment of the parties carried out the preliminary triangulation and traversing of the Godávari delta in preparation for a 16-inch cadastral survey which will be commenced in 1902-03.

An area of 1,306 square miles of forests was surveyed at a cost-rate of ₹59 per square mile.

25. In Burma an area of 724 square miles of forest reserves was surveyed on the 4-inch scale by No. 20 Party in the Upper Chindwin, Minbu, Pyinmana and Ataran. A large area was also triangulated and traversed for the current season's detail survey and in advance for that of 1902-03 principally in the Upper Chindwin, Minbu and Thayetmyo.

The cost-rates of triangulation and traversing both show an improvement. The cost-rates of detail work however show an increase being ₹122 per square mile, as compared with ₹98 in 1900-01. The increase is chiefly due to loss of time owing to the party being detained in quarantine at Rangoon, to the operations being much further from the base than formerly, and to the necessary transfer of a camp from Magwe to the Upper Chindwin during the field season.

26. In addition to the work done by No. 20 Party a small detachment of Forest Surveys surveyed 274 square miles in the Ruby Mines district at a cost of ₹85 per square mile. The cost-rate of this detachment cannot be compared with that of No. 20 Party, as the conditions were altogether different.

27. In the Central Provinces four detachments of the Forest Survey Branch were employed and, in addition to other operations, surveyed 699 square miles on the 4-inch scale in Mandla and 725 in Chánda. The survey of the forest reserves in the Central Provinces is now complete with the exception of an area of some 200 square miles in Chánda. The cost-rates of detail survey are even more favourable than for last year, being ₹29 per square mile, as compared with ₹36. The reduction is mainly due to the easier nature of the country in Mandla.

28. In Bengal one detachment was employed in Singhbhum and surveyed 369 square miles of reserved and protected forests on the 4-inch scale. A small detachment completed the survey of the Koderma forests (58 square miles) on the 4-inch scale chiefly for the purpose of locating the Mica mines. The cost-rate of 4-inch detail survey was ₹48 per square mile, as compared with ₹61 in 1900-01 and ₹80 in 1899-1900.

The steady reduction of rates in Chota Nagpur is very satisfactory.

29. In the Punjab the survey of the Jubbal and Tarhoch State forests was continued, an area of 100 square miles having been surveyed on the 4-inch scale at a cost-rate of ₹23 per square mile. A small area of 12 square miles was also surveyed in Hazára.

30. The total outturn of Forest Surveys executed on various scales during the year amounts to 5,035 square miles, of which 2,961 square miles were surveyed by the Forest Survey Branch (including 20 Party). The total is made up as follows :—

	Square miles.
4-inch scale	4,874
8-inch scale	161

CADASTRAL AND TRAVERSE SURVEYS.

31. During the year under report there was one cadastral party in Burma, one in Bengal and one in the United Provinces of Agra and Oudh.

32. In Upper Burma 545 square miles were surveyed in detail in the Lower Chindwin district, thus completing the cadastral survey of that district, whilst 911 square miles were traversed in the Pakôkku district preparatory to detail survey. In Lower Burma, 120 square miles were cadastrally surveyed to complete the Sandoway district, and 16 square miles, and 145 square miles traversed in districts Sandoway and Kyaukpyu respectively.

33. In Bengal, 4,171 square miles were traversed, 2,132 square miles cadastrally surveyed and 2,078 square miles of record-writing completed in districts Darjeeling, Monghyr, Purnea, Bhágalpur, Gaya, Backergunge, Sonthal Parganas, Singhbhum, and Ranchi, and small Government estates in Patna

district have been traversed, whilst surveys connected with the relaying of boundaries of other estates have been carried out in districts Malda, Champáran, Shahabad, Monghyr and Darbhanga, and a boundary in Jalpáiguri permanently marked.

34. In the United Provinces 181 square miles were traversed in Etah district, and 2,507 square miles cadastrally surveyed with record-of-rights by *patwari* agency under professional control in districts Azamgarh, Mainpuri, Etah and Jaláun.

35. In the Central Provinces, a number of small scattered areas consisting of excised portions of forest reserves in districts Damoh, Hoshangabad, Chhindwára, Nimár, Chánda, Raipur, Sambalpur, Mandla and Seoni were traversed, amounting in the aggregate to 715 square miles, whilst a disputed boundary between the *jagirs* of Pagára and Batkágarh, district Chhindwára, was also traversed. There remain some 671 square miles of these excisions to be traversed during 1902-03, and the detachment will in future be employed on the revision of the topographical maps of the Province.

36. In Assam 133 square miles of extensions of cultivated areas, and 94 square miles of tea grants were traversed, the former to serve as a basis for cadastral survey by local agency. There remain some 250 square miles of these tea grants for traverse during 1902-03, which it is estimated will complete them, and as the extensions of cultivated areas do not aggregate more than 50 square miles per annum, the retention of a professional detachment for the traversing of this small area annually, scattered as it is in small patches over the entire Province, seems hardly justifiable, considering the high cost-rate it necessarily incurs, unless some further extension of survey programme to suit local requirements is anticipated.

37. The total areas traversed, and cadastrally surveyed during the season in the several Provinces, are as follows:—

	Traversing square miles.	Cadastral survey square miles.	Record-writing.
Burma	1,072	665	...
Bengal	4,171	2,132	2,078
United Provinces	181	2,507	2,507
Central Provinces	715	...	...
Assam	227	...	...
TOTAL	6,366	5,304	4,585

SPECIAL OPERATIONS.

38. As there was only one Imperial Officer available for Astronomical work, Nos. 22 and 23 Parties were combined and Astronomical Latitudes were observed at stations on the Calcutta Meridional series and Darjeeling triangulation.

The results are very interesting and remarkable: the zone of positive deflection extends very much closer to the foot of the hills than was expected, and the transition from a positive deflection to a large negative one takes place with startling rapidity.

The whole question of local attraction in India, especially with reference to the effect of the mass of the Himalayas, is one of great interest, and has been partially dealt with by Major Burrard in an able paper published among the Professional Papers during the year. Many more observations and full discussion will be required before we can hope to solve this perplexing problem, a question which at present excites great interest in Europe.

39. Tidal operations were continued by No. 25 Party, observations being recorded at 13 stations. The observatory at Bassein, in Burma, was opened during the year.

The Levelling operations were carried on for a portion of the season on the Eastern Bengal State Railway, and a connection was made with the Sonákhoda Base Line. A commencement of Levelling was also made in Assam, a line of levels being run from Fakírganj to Gauháti.

An urgent call for accurate levels having been made by the Burma Government, the Levelling detachment will be employed in that Province during the coming season.

40. The Magnetic party commenced field work during the year. As the Bombay and Dehra Dún observatories were the only base stations in actual work, the field operations were confined to the country west of the line joining those two stations. As this was the first season of work only three observers were employed, and magnetic determinations made at 163 stations.

The Kodaikánal Base station is now installed, and that at Barrackpore, which is to take the place of the Calcutta one rendered useless by the electric tramways, is under construction. It will, therefore, be possible to push forward operations more quickly in the future.

GEOGRAPHICAL SURVEYS AND RECONNAISSANCES.

41. Under this head are included surveys and reconnaissances which are executed on the ¼-inch or smaller scales. In Sind and in Kashmir areas of 4,556 and 7,938 square miles, respectively, were surveyed on the ¼-inch and ½-inch scale, while country to the extent of 63,000 square miles was surveyed and reconnoitred in the Shan States and on the N.-W. Frontier.

A survey party under Lieutenant M. Tandy, R.E., has remained attached to the Aden Boundary Commission throughout the year.

HEAD-QUARTERS OFFICES, CALCUTTA.

42. The general direction of these offices remained in the hands of Colonel St. G. C. Gore, R.E., Surveyor-General of India, up to 31st January, and during his absence on combined leave Major F. B. Longe, R.E., officiated for him. The Revenue Branch Section was under the superintendence of Major Longe, Major S. G. Burrard, R.E., and Major W. J. Bythell, R.E.

The other offices in Calcutta were supervised by the Assistant Surveyor-Generals, aided by an officer, Captain E. A. Tandy, R.E., who was specially posted to the head-quarters in order to reorganise the working arrangements of the Mathematical Instrument Office.

43. The General and Topographical Branch Sections were under the supervision of Major G. B. Hodgson, I.A., up to 30th October, under Captain E. A. Tandy, R.E., up to 14th November, under Mr. A. E. Spring up to 2nd July, under Captain Tandy up to 13th July, and under Mr. B. G. Gilbert-Cooper up to the close of the year. The Drawing, Engraving and Map, Record and Issue Offices were under the supervision of Major J. M. Fleming, I.A., up to 9th July and during his absence on privilege leave Captain Tandy held charge of the Drawing and Engraving Offices and Mr. Gilbert-Cooper held charge of the Map, Record and Issue Office up to the close of the year. The Photo-Litho. Office was under the supervision of Mr. T. A. Pope throughout the year. The Mathematical Instrument Office was under Major Hodgson up to 30th October, under Captain Tandy up to 17th August, and under Mr. Gilbert-Cooper up to the close of the year.

44. A very interesting relic has come into possession of the Survey of India during the year. This is an original portrait in oils of Colonel Lambton, the originator of the Great Trigonometrical Survey of India, and its first Superintendent. The portrait, which is a very fine painting on copper, was sold to us by a descendant of Mr. dePenning, one of Colonel Lambton's Assistants, and, as far as the hands and face were concerned, was in perfect preservation. It has now been completely restored.

Major Lambton, an officer of the 33rd Regiment, after distinguishing himself at the storming of Seringapatam, placed before Sir Arthur Wellesley in 1800 proposals for a mathematical and geographical survey of the peninsula and the measurement of an arc of the meridian in connection therewith. The proposal was accepted and Major Lambton was himself appointed to conduct the measurement. In 1802, one hundred years ago, the work was commenced. The difficulties were many, but owing to his genius, ability and energy he conquered them all. It is characteristic of the difficulties to be overcome in those

times that the three-foot theodolite which was being sent out from England and captured on the passage to India by the French frigate "Piemontaise" was landed at Mauritius; but it was eventually forwarded to its destination by the chivalrous French Governor, with a complimentary letter to the Governor of Madras. The chain for his base line measurements was one that had been sent as a present to the Emperor of China with Lord Macartney's mission, and refused.

Lambton carried on his work steadily, covering Southern India with a network of triangles until 1823, in which year, on the 20th January, he died at Hinganghát in the Central Provinces. A reproduction of the portrait is published as a frontispiece to this volume.

45. *Correspondence Office.*—There has been no change in procedure throughout the year.

46. *Drawing Office.*—The General Section has, as usual, been engaged in the compilation and revision of the various general maps, as well as on additions to Standard sheets, when fresh material is available. In addition the sheets received from the parties are prepared for press and published. Thirty-five sheets of the North-Eastern Frontier Series on the scale ½-inch = 1 mile have been dealt with during the year, the majority being the result of recent work in China. Of these 25 have been published, the remaining ten being at press. Of the South-Eastern Frontier Series, 16 sheets have been in hand of which half has been published. Two sheets of the North-Western Frontier Series on the scale ½-inch = 1 mile, formerly issued in part with an adjoining sheet, as double number sheets, are now being prepared separately for publication in standard form completed to margin. Twenty-one sheets on the ½-inch scale, giving the results of the recent surveys done by the Survey Detachment with the China Expeditionary Force, were prepared for press and published. The sheets of the Andaman survey on the ½-inch scale have been under revision, a large number of additional names of localities having been entered upon them from information supplied by the Commissioner. They will shortly be ready for press.

One hundred and four Standard Sheets on the 1-inch scale have been dealt with during the year under report. Of these 36 belong to Burma, most of them being new publications, and of these six have been drawn in this office. Thirty-three sheets of Madras and seventeen of Rájputána and Central India are comprised in the number, the remaining sheets belonging to Assam, Bengal, Bombay and the Punjab. Press order has been given for 85 sheets, and of these 69 have been published.

47. Of sheets on the scale of 4 inches = 1 mile, 57 have been dealt with, 42 being Madras Forest sheets, and the remainder of the Burma Forest Survey, which have been brought up to date and republished.

48. Eighteen Provincial maps of sorts have been in hand either for revision or completion. One of these is the new North West Frontier Province, which has taken up much time and entailed constant references necessitating corrections and alterations, but it is hoped it will shortly be ready for publication, when the 16-mile Punjab from which it has been largely extracted, will be speedily completed.

49. The revision of the 16-mile Burma has been a most troublesome job, and the greater part of the map has had to be recompiled, as the old material being so faulty it was found impossible to put the new material on to it. To satisfy the urgent demands for the sheet which has been long out of print, a skeleton edition has been published, which it is hoped soon to supersede by a more correct one approaching completion.

50. Thirty-four District maps have been in hand, but kept up to date as they are, not from actual surveys but from information locally obtained, they are most unsatisfactory publications, and shortly it will be impossible to say what on many of them is good and what is bad material. Indeed the state into which all our sheets, standard as well as others, are drifting by the insertion of unreliable material, in the attempt to keep them up to date is a question that demands immediate attention. The material supplied us may serve to give a general idea of changes in a tract of country, but its insertion must lower the value of accurately surveyed sheets to that of mere reconnaisance work, to give it rank higher than it deserves. The system of handing over professional maps to be brought up to date by non-professional agency, which in many cases it is evident is represented by native clerks, is deplorable in its effect on our maps.

51. Fifty-two Administration Report maps have been in hand either for completion or revision. Of these 19 have been published while 16 more are at press. The hills for three of these have been brush shaded for the engravers.

52. One hundred and eleven sheets of the Atlas of India have been in hand for additions to outline or names or for corrections to roads, railways, canals and boundaries. These last taken from the same source as the alterations on our Standard sheets must much detract from their value, though the scale being so much smaller the information given may not be so misleading. But the constant alterations, as each new interpretation of a change comes from the local authorities, must do much to ruin the surface of the plates. Brush shading for the engravers has been executed on eight sheets, while a large amount has also been done on general maps such as the 32 and 64-mile India, etc. A commencement has been made of the compilation of an Index to show the material utilized on our Atlas sheets. Fair progress has been made, and when completed it should be a most useful addition to our records.

53. The new edition of the 48-mile Railway map has been completed, and it is hoped may be published early in the coming year. The 32-mile Railway and Canal Map of India has at last been published, but chiefly owing to the faulty hills is a somewhat unsatisfactory publication which it is hoped may soon be taken in hand again for rectification in several respects. The new 32-mile litho. map of India has been in hand throughout the year, as new material on both frontiers kept continually coming in. Sheets 1 and 4 have been much altered and added to, to incorporate the latest surveys. Sheet 1 is now practically ready for press, and it is hoped a skeleton edition at all events of the whole map, may issue during the coming year. The hill drawing of five of the sheets is ready for the stone draftsmen, and that of sheet 1 is also well in hand. The other general maps of India on the 64, 80, 96, 128 (2), 256 (2) mile scale have all been in hand, and editions of the first and fourth have been published. Work on the duplicate sheets of the 64-mile India has progressed steadily, but owing to new surveys having come in, much of the work already cut in Burma has had to be re-engraved. What has now been received must be final, and it is hoped to push it on without further delays during the ensuing year. Two sheets of the new $\frac{1}{1,000,000}$ map of India Nos. 78 and 83 are practically completed, and only await the settlement of certain small details before being sent for publication. Work on two other sheets, one of which is for the engravers, is well advanced. Work on the new engraved 32 and 64-mile maps of India has been at a standstill owing to press of other work. A new edition of the 32-mile Burma has been published, but this is a most unsatisfactory map and must soon be superseded by a better. To meet a long felt want, *viz.*, a map of India on a scale suitable for a foolscap report, a new skeleton map on the scale of 1 inch = 192 miles has been prepared and is now in the hand of the engravers.

54. Of city plans, that of Aijal has been published, while a map of Hsi-paw town has been sent to press. Forty-six of the sheets of the Calcutta survey have had revision work entered, and been published as second editions.

55. Extra departmental work has as usual taken up much of the office time and caused considerable interruption in our ordinary work. Many of the Census maps alluded to in last year's report were on receipt by the district officers pronounced either to have too much or too little detail, or to require alterations of some kind, and quite half have been largely modified. On the Assam, Bengal and Central Provinces maps a large amount of work was done in preparing the material for the colour stones for the various maps required to illustrate the reports of these Provinces. A set of maps was also prepared for the Census Officer in Balúchistán which were not included in the original programme, and also a general map of India on the scale of 1 inch = 192 miles was prepared for the Census Commissioner. The Route map of the Punjab and Bengal Command has at last been got out of hand. The Postal Atlas of India has been carried on as material or corrections became available, and what is hoped are final instructions regarding the Bengal and Bihár sheets have been received, and they should shortly be ready for press. The sheets for other two Provinces have been sent to the local officers for the insertion of information required, and these will be set in hand as soon as received. Other maps have been prepared in considerable numbers for the Foreign, Military, Forest and Medical Departments, as well as for the Botanical and Linguistic Surveys.

There is still a large amount of arrears in the way of bringing sheets out of stock up to date for republication, but the staff cannot anything like keep pace with demands.

The much needed revision of the Catalogues has once again had to be set aside for much of the year owing to various causes. But a considerable amount of work has been done upon them. That of Burma is practically ready for press, and those for Bengal and the Punjab will, it is hoped, shortly be ready, but owing to lack of staff they can only be taken up as opportunity offers.

56. The work in the Examining Section again shows a large increase, 2,977 sheets of sorts having come in for examination. Besides this there has been much work in the collection of geographical data for various officials, etc.

In the Revenue Section most of the outline for the new engraved map of Calcutta on the 6-inch scale has been supplied to the engravers, advantage having been taken of the presence of a surveyor to revise a part of the south district, which was much out of date. Maps of Bareilly, Allahabad, Cawnpore and of Calcutta for the Census report, and of Garden Reach for the Municipality, have been in hand, and all but the first two, which are delayed pending reply to references made about them, have been disposed of.

One hundred and eighty-one standard sheets of Assam, Bengal, Bombay, Burma, United Provinces and Punjab, of which 112 are new receipts from the field parties, have been dealt with during the year. Of these 78 have been published and 103 are passing through press. The new sheets received are mostly compilations of Cadastral Surveys in Burma, Bengal and the United Provinces, and many of the Burma ones are in such fragmentary condition they cannot be published until the work has been added to by new surveys. Four Burma sheets have been completed to margin from work supplied by the local surveys, and in two others area surveyed by the Forest Survey has been added to the material reduced from Cadastral Surveys. Fourteen old litho. prints of Bengal and the United Provinces, of which there are no originals, have been touched up to serve as such. Three Punjab sheets have been completed to margin by adding to them the hill area surveyed by No. 18 Party, which has been drawn for reduction on trace prints for publication in two colours. Two of these have been published. Four sheets have had work of other districts added to them to fill up blanks existing on the sheet as formerly published, and it is proposed in future to publish sheets as complete as possible. A recommencement has also been made of work which is sorely needed, and which has been unaccountably in abeyance for many years, *viz.*, the preparation of the scattered material in Bengal, such as *pargana* or main circuit maps, for publication in standard form. Three sheets have been in hand, and it is proposed to keep any available men on this task until all are completed. There is of course nothing but the ancient surveys to recompile, but the possibility of obtaining in readable form in one sheet, what at present is to be found only in several, should be a convenience to the public, and will be an untold boon to the Map, Record and Issue Office. The sheets before publication will be sent to the local authorities for the insertion of any new public works.

The usual work of revision has been carried out on the Index maps, while several new ones have been prepared. Two thousand one hundred and twenty-six pages of extracts from traverse data have been copied, checked and supplied as required by Departmental or other Government officials. The traverse records of district Toungoo have been finally examined and lodged again in the Map, Record and Issue Office. Those of district Saran are now in hand.

Seven hundred and forty-five traces and copies of 361 original village plans have been supplied to District Officials, while 1,210 applications from private parties for copies of original records have been received and disposed of during the year. On those applications 1,934 copies of maps or traverse records were supplied. The Government fees realised amounted to R1,294-2.

Coloured maps for issue to a number of 17,742 have been examined and passed, and in addition 1,409 pairs of office copies have been either newly prepared or brought up to date and compared. A total of 4,191 pairs have now been dealt with.

The renumbering of the published Burma sheets has also been in hand and 1,749 copies have had new numbers pasted upon them. All the 1-inch sheets

have been finished, but a number of large scale maps still remain to be dealt with and these will be taken up as opportunity offers.

In the Cadastral Section the returns for last year showed 5,937 sheets of Burma as remaining to be published, and during the year under report 2,770 original Cadastral sheets of districts Shwebo, Yamèthin, Lower Chindwin and Kyaukse Town of Upper Burma, and 302 sheets of Pegu and Toungoo City in Lower Burma were received from the field party. Six thousand five hundred and fifty-one sheets have been published, a large increase on former years' totals, leaving a balance of 2,548 to be completed, and these it is hoped to finish off by the end of January.

The total number of sheets passed for publication was 6,599, of which 4,596 were photozincographed, 1,035 zincographed, and 920 reproduced by the Vandyke process.

In addition to this much miscellaneous work has been done for Settlement Officers, Collectors and others. A large order for traces of 1,402 sheets of Myingyan district has been complied with.

Badar corrections have been made in the field area statements of districts Cachar, Sagaing and Shwebo. The making out of invoice lists to accompany the original Cadastral sheets and area statements of districts Sagaing, Magwe, Meiktila, Pegu and Toungoo of Burma and Raipur of the Central Provinces with area statements of Prome and Bilaspur has thrown a considerable amount of extra work on the section, as before the despatch of consignments under recent orders to the local authorities for storage, each sheet has to be examined and checked, this work will be carried on as fast as possible, but without extra staff can only be done as opportunity offers.

57. *Engraving Office.*—The work performed by this office is in amount much the same as last year. Owing to the absence on leave of three European hill etchers and several of the native establishment, the outturn of hill etching and outline is somewhat less than usual, but the letters cut show an increase of 24,546. Only one new quarter Atlas Sheet has been published during the year.

Seven Administration Report Maps and editions of the general maps of India with hills on the 64 and 128 miles=1 inch scale have also been issued, and a new index to the Atlas Sheets which was much needed has also been completed. Thirty-three new quarter Atlas Sheets have been projected, 107 sheets in various stages have had additional work done upon them, while 145 published quarter sheets, and 17 full Atlas Sheets, have been in hand for additions and corrections.

Seven of the Provincial maps on the scale of 1 inch=16 miles have been in hand. Sheets 2, 3 and 4 of the Punjab map are almost ready for publication, but sheet 1 has been much delayed pending settlement of certain points in connection with the map of the new North-West Frontier Province which has been prepared from it. It is hoped that these are finally settled now, and that work on this long delayed sheet may soon be resumed.

The other maps dealt with have been those of Bengal, Assam, Central India Agency, Central Provinces, Madras and Rájputána. Considerable progress has been made with the map of the Punjab on the 32-mile scale.

But little work has been done on the new map of India on the 32-mile scale. The projections of sheets 8, 11 and 12 have been completed, and the degree figures cut, while corrections on a matrix of sheets 7 have been completed. On sheets 1 and 3 of the old plate a considerable amount of additions to railways and names has been cut.

Sheets 1 and 2 of the duplicate 64-mile India have been in hand. Unfortunately a considerable amount of revision from new surveys was required on them and this has delayed them, but as much final material is now ready for them work upon them should now progress steadily. Other maps of India on the 80-mile (Railway map) 96-mile, 128 (Outline) and 256-mile scales have all been in hand for large additions and corrections. The last should be ready very soon.

The new 192-mile skeleton Map of India has had the title and graticule cut, and work on the outline will begin at once.

The new engraved map of Calcutta on the scale 6 inches = 1 mile has made satisfactory progress, most of the outline having been cut. Sheets 3 and 4 are still in hand.

Eight of the Provincial Index Map plates have been corrected and brought up to date.

Five of the plates of the new $\frac{1}{1,000,000}$ map have been projected and had the degree figures cut, and work will be commenced upon them on receipt of material from the Drawing Office.

As usual a considerable amount of work for outside departments and miscellaneous jobs have been done such as Commission Forms, Weather Report plates, scales, etc. Forty-eight plates have had corrections filled in by electro deposition with most satisfactory results. The copper-plate printing section pulled 26,054 impressions, again an increase on last year's outturn, but this is largely due to the smaller size of many of the sheets dealt with. Fifteen transfers from the copper-plates have been sent to the Photo.-Litho. Office so that Atlas Sheets which the Engraving Office could not issue might be printed from stone. No less than 134 Atlas Sheets are still out of print, and until the new presses are received from home there seems to be no chance of the office being able to keep pace with orders.

58. *Photographic and Lithographic Office.*—This office remained in the charge of Mr. T. A. Pope, Assistant Surveyor-General, throughout the year. The very large outturn recorded last year has been exceeded during the year under report, the number of copies of maps, plans and other subjects reproduced by lithography and photozincography being again greater than in any previous year. There was a very considerable increase in the amount of work done for the Survey of India, and a corresponding decrease in the amount done for other departments. As the latter class of work has of late years increased to such an extent as to seriously interfere with the reproduction of departmental mapping which should be the first and most important duty of the office, this reduction in the quantity of work received from outside, enabling the office staff to be employed to a larger extent on departmental work, is an important and satisfactory feature in the year's operations. Excluding cadastral maps, the number of copies of departmental maps printed during the year was 251,025, or 58,559 more than last year. Of cadastral maps, 270,871 copies were printed, or 17,876 more than last year. This large cadastral outturn is due to the fact that the reproduction of the Bengal maps, which it was expected would cease in April 1902, was continued till September, as the Bengal Drawing Office was not in a position to take it over till then. Urgent demands were also made by the Burma Government for an increase in the rate of supply of their cadastral maps, and a small addition to the printing establishment was sanctioned by the Government of India up to the close of the current financial year, in order to effect this. The number of subjects sent in for reproduction by other departments was 1,060, or only about half the number received last year; while the number of copies printed was 632,233, or 76,122 less. The aggregate outturn of the lithographic machines and presses reached the large figure of 1,154,129 printed copies, which is practically the same as last year, when it amounted to 1,153,816.

Less work was done in the Type-printing Section, the total number of pages set up being 12,443, as against 14,602 last year and of copies printed, 976,968, as against 984,189. In the Silver-printing Section also the outturn was less, there having been smaller demands for the class of work carried on in the Section than usual. In the Heliogravure Section a large increase is recorded, the number of plates photo-etched amounting to 157, or 42 more than last year, while the number of copies printed from photogravure plates reached the large total of 88,070, or 29,288 more than last year. This is considerably the largest outturn yet recorded for the Section, and it was attained without any increase to the staff or printing power employed.

The following are the principal items of work on which the office was engaged during the year:—

In the Lithographic Branch, considerable progress was made with the new 32-mile map of India, with hills, in six sheets, referred to in paragraph 58 of last year's Report. Five of the six sheets are now completed in outline, and of these, sheets Nos. 3, 4, 5 and 6 were done during the past year. The hills, which are being drawn in chalk on stone, were completed for two sheets, and a third hill stone is now in progress. The Railway and Canal map of India, on the 32-mile scale, referred to in last year's report as being almost ready for publica-

tion, was completed and printed off in March 1902. A Telegraph map of India, on the 32-mile scale, has been in progress throughout the year; proofs of two of the six sheets were submitted to the Director General of Telegraphs for approval, and two others were in hand at its close. A map of India showing the Railway Mail Service system, on the 32-mile scale, was drawn on stone during the year in black and eleven colours; proofs were submitted and these have since been returned with correction and press order. Work on the new Military map of India, on the 32-mile scale, which has been in hand since February 1899, was stopped at the request of the Quarter Master General in India, and an entirely new map has been put in hand to take its place. In this, the outline stones prepared for the railway and canal map are being utilised instead of old and worn-out stones of the old 32-mile map, and the military information is being shown in red. Six small maps of India were prepared for the Report of the Census Commissioner in India. A map of the Punjab and Kashmir, on the 16-mile scale, was put in hand and proof of one of the four sheets was submitted. An Irrigation map of the United Provinces of Agra and Oudh, on the 8-mile scale, was put in hand for lithography; two sheets are in progress and one remains to be taken up. About 40 district maps have been dealt with during the year; proofs of 14 of these were submitted, and several have been returned with corrections which are now in hand.

59. In the Photographic Branch, a map of Afghánistán, on the 16-mile scale, in four sections, with hills in brown, was photozincographed and 1,000 copies were printed off for the Quarter Master General. A Postal map of Rangoon, on the scale of 1 inch to 1,000 feet, was photozincographed for the Rangoon postal authorities and printed off. A Route map of the Bengal and Punjab Commands was photozincographed for the military authorities and 1600 copies supplied. For the Marwar State, a map of Marwar in *Deb Nagri*, in eight sections, was photozincographed in five colours and 1,000 copies supplied. Manœuvre maps on various scales of the country round Meerut, Bareilly, Fyzabad, Nágpur, Maymyo, Mandalay, Jhánsi, Secunderabad, Neemuch, Mhow, Nasirabad, Umballa, Calcutta, Shwebo and Benares were prepared for the military authorities. Of City and Cantonment maps, a map of Aijal station, on the 24-inch scale, and of the city, civil station and environs of Cawnpore, on the 12-inch scale, in 15 sheets, were also photozincographed and printed off. Five Census maps, in colours, of Assam, and three each of Balúchistán, Bengal and the Central Provinces were photozincographed and 1,000 copies of each printed for the Census Commissioners of those Provinces. A considerable number of sheets of the Madras forest surveys were reproduced and printed off. Four hundred and twenty five standard sheets of the Topographical and Revenue Surveys on various scales were either reproduced as new publications or reprinted during the year.

60. The arrival in February 1902 of the new camera, intended for the reproduction of standard sheets and other large maps in one reversed negative, as described in paragraph 59 of last year's Report, enabled the Office to introduce a very important change in the methods in use of dealing with such maps. The old process by which standard sheets were photographed in two or more sections, the negatives being afterwards printed separately on carbon transfers to be joined together before being transferred to zinc, has now been practically abandoned. This method, which has been in use for many years, had serious disadvantages: it was not only troublesome and slow, but it gave inferior results and rendered the registration of colour work practically difficult. By taking the whole map in one reversed negative and printing it direct upon the zinc all these disadvantages have been removed; work is turned out more quickly and the results are sharper and free from distortion. The method, now known as Heliozincography, by which the reversed negative is printed direct upon the zinc was worked out in the Office, is entirely novel, and is a decided improvement on any of the older methods. A full description of it is given in the separately printed Extracts from the Annual Reports of the Survey of India.

61. During the year another important change was brought gradually into effect by the substitution of the new Vandyke process for photozincography for the reproduction of the regular cadastral work of the department. The success which has attended the employment of this method for the reproduction of the Bengal cadastral maps led to its being utilised for the Burma sheets also, and

these are now being traced in the field party office for the purpose. The results have given entire satisfaction. The rates are much lower than the old cadastral rates, and the copies are despatched with less delay than formerly. At the close of the year a large number of sheets which had previously been prepared for photozincography, and were therefore unsuited for the Vandyke process, remained to be dealt with, but these will be cleared off by the middle of February 1903. After that time no more cadastral maps will be reproduced by photozincography and consequently a reduction in the strength of the Negative Section, on the cadastral side, will take place. In this connection Mr. Pope points out that it will not be advisable to effect any large reduction of the Office establishment generally, as it is becoming urgently necessary to increase the staff of Lithographic draftsmen, work being seriously delayed by the insufficiency of drawing power. The want of a small number of additional posts in the lowest grade of the fourth division is also seriously felt, as at present no means exists of providing for the proper training of printers and machinemen. Proposals will therefore be made early next year for a rearrangement of the posts in this Office with the view of rectifying these defects.

62. In September 1902 Mr. Pope submitted a proposal for the substitution of electric motors for steam power for driving the printing and other machines. As the engine which is now in use is showing signs of wearing out, and has already caused much inconvenience by breaking down on more than one occasion, a new engine would in any case be required erelong. There is much to recommend the suggested change. Electricity, when used under the conditions which obtain in this Office, is slightly more economical than steam power, though its installation would cost somewhat more than the erection of a new engine. The great advantage would lie in the fact that each machine, having its own motor, would be independent of the rest and could be switched on and off whenever required, and consequently there would be no waste of power when it was not running or liability to a general breakdown and consequent stoppage of work. Further advantage would be gained by doing away with the shafting and belting, and with the nuisance caused by the smoke from the Office chimney. The sanction of the Government for the new installation will shortly be applied for.

63. *Map Record and Issue Office.*—Work in the Map Record and Issue Office has, as usual, been unceasing and with difficulty coped with. The staff sadly requires augmenting, and until this is done delays in the supply of maps, records, etc., must be anticipated. The staff must now habitually work overtime to comply with demands.

64. Two hundred and seventy thousand, two hundred and four maps of an aggregate cost of R3,07,905 were issued during the year. Of this sum R14,438 were realized from private sales. The number of new maps received for publication was 3,267, of which 3,072 were cadastral sheets. Besides these 4,089 original volumes of records, maps, etc., were issued from the office to other branches of the department and 1,318 were returned back into store.

65. Apart from the question of space available for them, the accumulation of maps of all kinds is becoming a serious matter. If all our sheets could only be published in standard form a great clearance would at once be effected. The old system of surveying country by *parganas* or main circuits or even by districts was a most fatal one for storage purposes. It often happens that to furnish the area comprised in one standard sheet, three or four sheets and often more of these fragmentary surveys have to be hunted out and supplied, and the searching for and joining up these complementary sheets, means an immense amount of labour for our already insufficient staff, which the public, irritated over delay in supply, cannot understand.

66. The work of clearing out the accumulated bundles of maps from the roof spaces has been carried on throughout the year. Five new racks containing 180 double shelves were constructed by the Public Works Department in a vacant space, and in these five copies of each of 1,789 non-departmental maps or old editions have been put away after being flattened out, numbered and checked with the register. The sheets so dealt with are those of the Punjab, Rájputána and the United Provinces; and constitute about a third of the total stock. Thirty-nine shelves were built departmentally and in these the five stock copies of each of such of the Forest Survey large scale maps which have been

sorted out, have been stored by provinces, and they will be kept thus separately in future.

67. The most satisfactory task accomplished has been the reconstruction of the almirahs for the storage of our original sheets. Built originally of dimensions suitable for the old main circuit maps, sheets of the modern standard size or larger could only be inserted after folding; a practice which has been found to have irretrievably damaged a good many. Entire reconstruction was found necessary, the old material being used as far as possible. Could the whole room have been dismantled at once and rebuilt afresh the business would have been more satisfactory, but as only two racks could be dealt with at a time, defects exist which might under better conditions have been avoided. Though the racks are larger, there has been no loss of storage room. The racks, formerly open at the back, have been closed in, as is evident had formerly been the case, and apparently been found unsatisfactory; whether this will again have a detrimental effect on the paper remains to be seen, but it is a choice of evils, as open—in spite of poisons and disinfectants—rats, cockroaches, etc., were found to have ruined many sheets. The doors are continually opened during office hours to allow of ventilation, and no evil results are apparent so far. The only effective preventive of the inroads of vermin among such perishable materials seems to be constant inspection.

68. The Government of India having decided that cadastral originals after publication are to be in future stored at the head-quarters of Provinces, the sheets of five districts of Burma (Sagaing, Toungoo, Magwe, Pegu, Meiktila) and one of the Central Provinces (Raipur) with their connected area statements have been despatched from this office. In addition, the area statements have been sent of Prome and Bilâspur; the cadastral sheets of the last district being already with the local authorities. Further consignments will be sent as soon as sheets can be checked and invoiced, but as no extra staff is sanctioned for this extra work, some time must elapse before all can be despatched from the office.

69. In the *Mathematical Instrument Office* this year was especially noticeable for the introduction of the piecework system in the workshops, and for greater freedom in the management of the budget allotments. Sanction for these reforms was granted in Government of India letter No. 1621—34-2, dated 17th July 1901, from Revenue and Agricutural Department. Captain E. A. Tandy, R.E., was placed on special duty and posted to the charge of the Mathematical Instrument Office in order to carry out the changes and reforms incidental to the introduction of the new system.

70. Piecework was only commenced at the close of 1901, and had to be very gradually introduced, so that it was far from being thoroughly established by the close of the financial year in March 1902. Notwithstanding this it resulted in an immediate increase of outturn in the workshops; while the freedom to engage the requisite additional staff enabled the whole of the serviceable stores to be rearranged and put into proper order; it is hoped that they may never again be allowed to relapse into their previous state of confusion, which was due to the staff having been for a long time very much undermanned.

71. Arrangements were also made for indenting piecemeal on the India Office for European stores; that is to say, small indents can now be sent in from time to time, instead of the whole allotment being expended in a single indent at the beginning of the year. By this means the indents can be more easily adjusted to meet the varying requirements of the year, and a great deal of hurried local purchase of European stores at the last moment can be avoided.

72. By observing careful economy in this respect and by relying on the increased efficiency of the workshops under the new system, the amount spent on the local purchase of European stores was reduced to R17,793 as compared with R36,024 in the year before, the latter sum being itself rather less than what was spent under this head in previous years.

73. It is most desirable that the whole of such savings should be expended, in accordance with Government sanction, in renovating the large store of repairable instruments, so as to enable them to be reissued in place of buying new ones; but the piecework system was commenced very late in the year, and the full capacity of the workshops could not be economically developed in a moment. However, although the workshop outturn was in every respect much

increased, and in spite of the extraordinary expenditure involved in reorganizing the stores, a nett saving of R11,319 was effected on the year's budget.

74. Towards the close of the year the arrangements for sorting and registering the office correspondence were remodelled to meet the necessities of the great increase of work in all directions which has occurred in recent years, and definite arrangements were made for carrying on the work of receiving, packing, despatching, etc., on a more orderly and expeditious system from the 1st April 1902. The results of these alterations have so far proved most satisfactory.

75. The book value of the serviceable stores in hand at the end of the year was R5,13,547 as compared with R5,36,053 at the end of the previous year. That of repairable stores was R2,30,155, or 11,056 less than in the previous year. A reduction in both these items is most satisfactory, as the former store is in many respects overstocked, while the latter has attained almost unmanageable dimensions in the past, owing to the inability of the workshops to cope with it. The decrease in the latter store is especially creditable as there was a very large increase in the value of instruments deposited by public officers; the value for the year under report being R73,146 as compared with R49,718. If it had not been for the introduction of the piecework system it would not have been possible to cope with this large inflow of discarded instruments, and the repairable store would have been still further increased, instead of reduced, as a result of the year's working.

76. There was an increased expenditure in the workshops of about R5,000 in labour and R6,500 in material; but as a set-off against this increase of expenditure there was an increase in the workshop turn-out of nearly six thousand rupees in manufactures and ten thousand in repairs for store; and the large saving on local purchases noted above was made possible. The outside repair work done for public officers was valued at R29,333, which is slightly less than last year.

Since the close of the financial year on the 31st March this development has much increased, and a still more satisfactory statement of the results of the piecework system may be confidently expected at the close of the current year.

77. There was an increase of about ten thousand in the number of instruments issued during the year; the total value being R2,84,719 as compared with R2,77,715 in the previous year.

78. Considering the all-round increase of work, there was a satisfactory decrease in the number of instruments indented for from the India Office, the total value being £4,262. Charges of this kind do not altogether lie in the hands of the management as they depend largely on the demands of outside departments which have to be met; but it is satisfactory to find that every effort is being made to reduce them to a minimum.

79. This piecemeal method of examining results can give no more than a vague idea of the year's progress, but it is the only one available under the present system. It is hoped that arrangements may be made for exhibiting the results of the management more clearly by bringing all figures together into a brief profit and loss statement. At present the profit and loss account is made out for the workshops alone. This is necessarily a somewhat artificial arrangement and has been found to have grave defects as a means of indicating the real state of affairs. The workshop outturn for the year has already been shown to have developed very considerably, and the profit and loss account shows gross credits of R1,09,875 and a loss of R1,308, compared with a profit of R552 and gross credits of R97,205 in the previous year.

80. The Surveyor-General wishes to acknowledge his great indebtedness to Captain Tandy for the energy and ability he has displayed in reorganising this office and its work, and also to the Mathematical Instrument-maker and Assistant Mathematical Instrument-maker Messrs. Theakston and Ferrier for their whole-hearted zeal in introducing the new system. The change of method has entailed very hard work on them, but they have cheerfully taken it in hand and devoted their whole energies to make it a success.

BRANCH OFFICES.

81. The Trigonometrical Branch was under Major S. G. Burrard, R.E., Superintendent, Trigonometrical Surveys, up to 1st February, when he was

appointed to officiate as Deputy Surveyor-General, Revenue Branch. He made over charge of his duties to Mr. J. Eccles, M.A., who continued in office to the end of the year. Mr. McA'Fee held charge of the technical offices up to the 1st December, when Mr. Eccles, on return from furlough, took over charge and continued in office up to 1st February, when he was relieved by Lieutenant F. B. Tillard, R.E. Mr. McA'Fee on return from leave on the 3rd April relieved Lieutenant Tillard, R.E., and continued in charge to the close of the year. Two Professional Papers, No. 5, "The Attraction of the Himalaya mountains on the plumb line in India," and No. 2 of 1902, "Account of a determination of the co-efficients of expansion of the wires of the Jäderin Base-line Apparatus," were printed and issued. Professional Volume XVI, "Details of tidal observations taken during the period from 1873 to 1892 and a description of the method of reduction," Synoptical Volume XXIX, "Great Arc Meridional series section 8° to 18°," and Addendum to Synoptical Volume XXXIII, "Cutch Coast series," were published and issued. Professional Volume XVII, "Electro-Telegraphic Longitude Operations, executed during the years 1894 to 1896," is now in the hands of the binder and will shortly be issued. The usual routine of map publication was carried on in the Photozincographic section, the greater part of the work consisting of reproduction of maps for the Forest Department and standard maps. The usual meteorological observations were continued and photographs of the sun taken on every day that the sun was visible. In the drawing section a special set of maps of the country surveyed under Dr. Stein in Central Asia was prepared. At the urgent request of the Punjab Government, district maps of Kángra and Kullu have been put in hand, but owing to the small staff of draftsmen, this has necessitated the putting aside of other important work, such as the level charts and the sheets of the map of India on the 1—1,000,000 scale. As these exceptional demands are nearing completion, it is hoped that the regular work of the section will soon be resumed. Three officers of the Imperial Service, Lieutenants F. B. Tillard, R.E., R. H. Thomas, R.E., and L. C. Thuillier, I.A., went through a practical course of trigonometrical, topographical, and astronomical work, and seven sub-assistant superintendents of the Provincial Service were put through a course of topographical surveying, levelling and mapping.

82. The offices of the Forest Surveys, Bengal Presidency, were under the superintendence of Major P. J. Gordon throughout the year, and were employed as usual on correspondence and accounts, computations, area statements, the mapping of field surveys, the compilation of working plans and other special maps, and the up-keep of the map records of the Forest Department. During the year 284 maps have been sent to press and 298 have been published, including 10 working plans and other special maps. On the 30th September over 400 maps were in different stages of progress and 178 were in press. Four thousand seven hundred and four printed maps have been distributed, of which 3,219 were coloured and 2,053 were mounted in book form.

The inconvenience and unsuitability of the present Forest Survey office having been brought to notice, Government has sanctioned the erection of a suitable fire-proof building in the compound of the Great Trigonometrical Survey office at Dehra Dún as a permanent office for the Forest Survey Branch and for storing the rapidly increasing maps and records. When the building is ready, it is proposed that the custody and issue of all forest survey maps should be in charge of the Superintendent, Forest Surveys: this should form a considerable relief to the already congested condition of the Map Record and Issue Office at Calcutta.

83. The *North-West Frontier Drawing Office.*—Under the superintendence of the officer in charge No. 15 Party this office was employed as usual at Mussooree on trans-frontier compilation and a certain amount of miscellaneous work for the Intelligence Department. A commencement has also been made with the compilation of the frontier sheets of the new map of "India and Adjacent countries" on the scale of $\frac{1}{1,000,000}$. Six sheets of this are in hand, some of them being nearly completed. A good deal of trouble is experienced in making an intelligible reduction of the intricate hills which are surveyed in full detail on the larger scale maps.

LOCAL DRAWING OFFICES.

84. These have been established for the purpose of compiling one-inch topographical maps from the cadastral surveys that have recently been carried out in various Provinces.

In the United Provinces one is located at Naini Tal, one in Bengal at Calcutta, and one in Assam at Shillong, all in charge of the Superintendents of Provincial surveys in those Provinces.

The maps so obtained are published as preliminary editions and require revision in the field and completion of topography when establishments for the purpose are forthcoming.

Similar drawing establishments exist in the Punjab, and Central Provinces where revision surveys are in progress, these establishments being integral portions of the parties carrying out the revision surveys. The cadastral surveys by local agency are reduced by pantagraph to the 2-inch scale on to plane-table sections, which are then tested in the field, and all topographical details omitted by the local surveys are filled in and completed for the standard maps. The outturns of these drawing offices are detailed in the reports in Part II.

The drawing offices for the compilation of geographical maps on the North-Western and North-Eastern Frontiers of India and Burma were employed as usual at Mussooree and Bangalore.

ESTABLISHMENT.

85. During the year under report the Department has lost the services of one officer of the Imperial Service.

Mr. A. E. Spring, Deputy Superintendent, 1st grade, died at St. Kilda, Australia, on the 2nd September. Prior to his appointment in the Survey of India Mr. Spring was attached to the Bombay Revenue Survey from August 1881 to February 1891. On joining this Department he was posted to Burma, where he was attached to and held charge of Revenue Survey operations there. His health having broken down he was attached to the Head-Quarters Offices from 1896.

86. In the Provincial Service the Department has lost the services of seven officers during the year, *viz.*, by the retirement of Messrs. W. Stotesbury, R. B. Smart, J. Connor, A. J. James, G. W. Jarbo and Munshi Yusuf Sharif, Khan Bahadur, and by the death of Mr. J. Murphy.

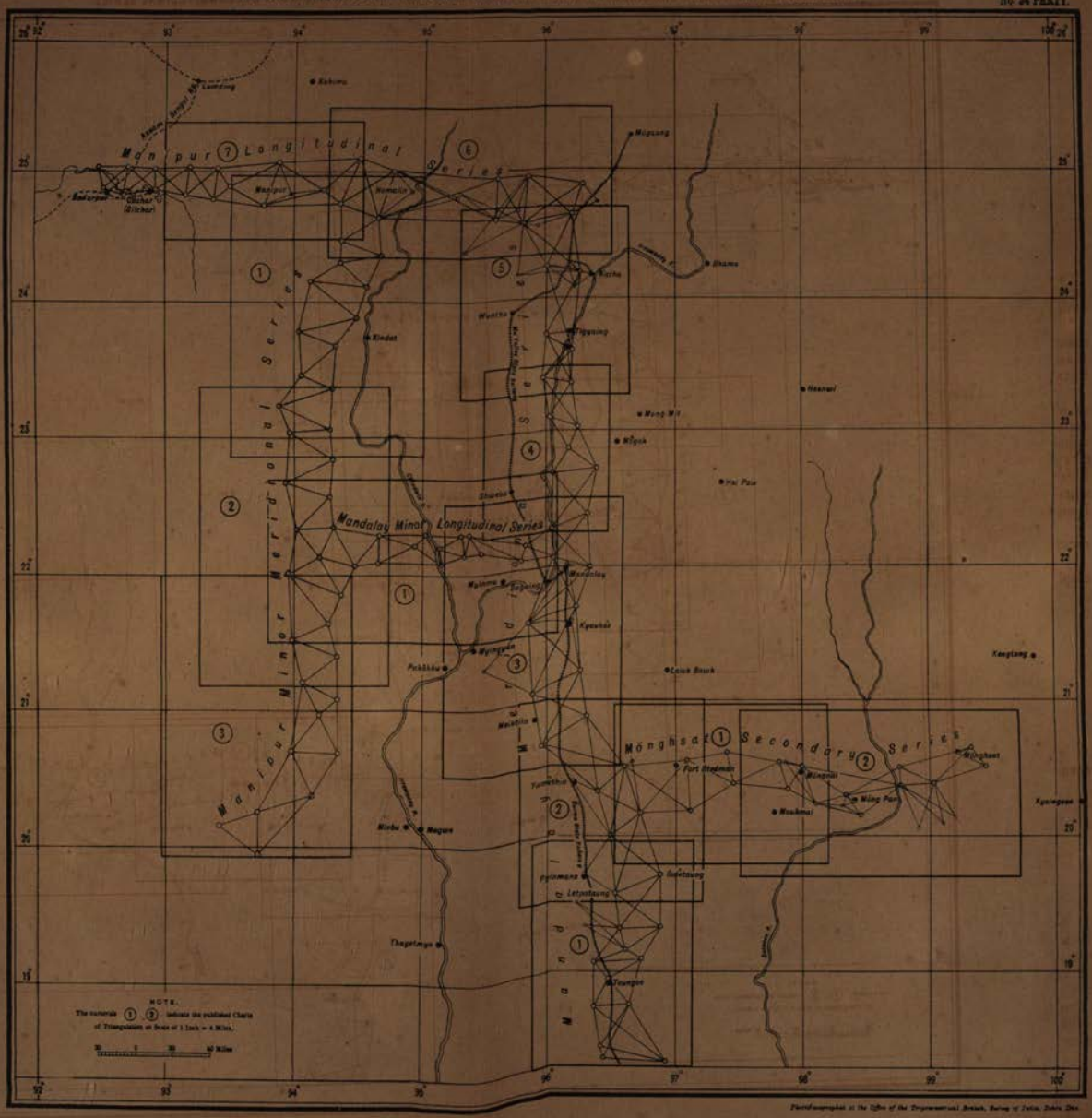
LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

INDEX TO THE CHARTS OF THE PRINCIPAL TRIANGULATION

OF THE

MANDALAY MERIDIONAL AND LONGITUDINAL AND MANIPUR MERIDIONAL AND LONGITUDINAL SERIES.

No. 24 PARTY.


Manipur ⑦ Longitudinal Series
⑥
Manipur Meridional Series
Mandalay Minor Longitudinal Series
Manipur Minor Meridional Series
Mönghsat ① Secondary ② Series
Mandalay ① Meridional Series
Kohima
Mokokchung
Manipur
Imphal
Bishenpur
Silchar
Pilcher
Kindat
Wuntho
Shwebo
Monywa
Kyaukse
Pakkoku
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Pyinmana
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Kabaw Valley
Kabaw Valley
Kalemyo
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Kyaukmyaung
Pyinmana
Pyinmana
Letpadaung
Letpadaung
Thayetmyo

PART II.

THE OPERATIONS OF THE SEVERAL FIELD PARTIES.

TRIGONOMETRICAL SURVEYS.

INDIA TRIANGULATION.

No. 24 Party.

87. The party remained under the charge of Lieutenant H. Wood, R.E., except from 19th May to 19th July, when he was on examination leave, during which period Lieutenant H. McC. Cowie, R.E., held charge.

88. The party left recess quarters at Mussooree on October 14th and reached Pakôkku, Upper Burma, on November 10th. The programme for the season was to complete the Manipur Minor Meridional series and to close it on to two stations of the Burma Coast series.

89. Observations did not begin till December 2nd owing to the distance of some of the stations from Pakôkku, but the work was, after several delays, satisfactorily completed on March 8th. The mean difference between the 2 values of the closing stations are 0″·186 in latitude 0″·200 in longitude and 6″·137 in azimuth. Considerable difficulty was experienced in crossing the Kyaukpyu Yomas owing to the absence of inhabitants and paths. About 1,000 square miles of hitherto unsurveyed country was sketched on the ½-inch scale by Lieutenant Wood.

90. The party reassembled at Akyab and, proceeding *vid* Calcutta, reached recess quarters in Mussooree, where the office reopened on 14th April 1902.

91. Messrs. Troughton and Simms' 12-inch Theodolite No. III was employed and measures were taken, as in previous seasons, on 4 zeros.

The season's outturn of work was as follows:—

Minor Triangulation.

Number of stations newly fixed	10
Number of figures completed	10
Length of series completed in miles	148
Area of triangulation in square miles	2,800

The mean triangular error, was 1″·62.

92. The Superintendent, Trigonometrical Surveys, inspected the party in recess quarters on 12th September 1902.

TOPOGRAPHICAL SURVEYS.

LOWER BURMA.

No. 3 Party.

93. Mr. Litchfield remained throughout the year in charge of this party, which left recess quarters at Bangalore on the 1st November, and commenced work in Burma between the 15th and 20th idem. The field season was closed on the 20th May and the office opened at Bangalore on the 6th of June 1902. The party was divided into four camps: the head-quarters camp at Prome, camp No. I in the Pegu and Hanthawaddy districts, camp No. II in the Thayetmyo district, and camp No. III in the Toungoo district, each under a Provincial officer.

94. The programme of work for the season comprised—

(*a*) The triangulation of parts of standard sheets Nos. 75, 76, 113, 204 and the whole of 157.

(*b*) The detail survey on the 1-inch scale of the unsurveyed areas of sheets 115, 159, 206, 207 and, if possible, 164.

(*c*) The detail survey on the 2-inch scale of the unsurveyed areas in sheets 253, 254, 255, 261 and 262.

(*d*) The revision of the cadastrally surveyed areas in sheets 253, 254, 255 and 262.

With the exception of the triangulation under (*a*) and the topography of a part of sheet 206 under (*b*) this programme was adhered to and successfully accomplished. As it was possible and more convenient to survey the areas in sheets 253, 254 and 255 on the 1-inch scale, this scale was adopted instead of the 2-inch as originally proposed. The triangulation under (*a*), not being urgent, was abandoned in favour of that required for the revision of the cadastrally surveyed areas of sheets 253, 254, 255 and 262.

A certain amount of traversing not included in the programme was also undertaken in these sheets.

95. The outturn for the field season is as follows :—

	Sq. miles.
Detail survey on the 1-inch scale	1,905
Revision „ „ „	1,048
Detail „ 2-inch „	350
Triangulation for revision survey	1,530
Traversing { square miles	141
Traversing { linear miles	65

This outturn compares favourably with that of previous seasons and excluding the revision survey of 1,048 square miles is over 1,000 square miles in excess of that of last year.

In the area topographically revised a few traverse stations (village trijunctions) *pagodas*, etc., in each sheet were trigonometrically fixed to check their positions geographically and to provide heights; some new roads, forest boundaries and hills were added, and the revision or supplementary surveys of the Land Records Department in progress at the time, were utilised.

The spelling of the names in both the field sheets and published sheets was corrected by the Translator to Government in the Burma Secretariat, an arrangement made by the Director of Land Records.

The completion of standard sheets 259, 260, 261 and 262 brings the 2-inch surveys to a close and, in future, the remainder of the country will be surveyed on the 1-inch scale.

96. The total expenditure of the party is R90,184 and the cost-rates per square mile are as follows :—

	R
Detail survey on the 1-inch scale	26·8
„ „ 2-inch „	72·5
Triangulation for revision survey	5·5
Traversing for 2-inch and 1-inch survey	37·3

It is not possible, if the triangulation be excepted, to work out a rate for the revision survey as this work was undertaken by various men at odd times during the progress of their other work, and much assistance was given by the Land Records Department in localities in which their revision survey was in progress. The triangulation, with the exception of about 170 square miles, was undertaken only for the revision survey. Its cost, R5·5 per square mile, may therefore be debited to this survey.

The cost-rates are comparatively low, and are nearly half of those of last year, while the total expenditure exceeds that of last year by only R300. But in considering cost-rates in Burma, particularly in Lower Burma, it should always be remembered that the conditions under which work is carried on are very unfavourable, and that interpolation and sketching with the plane-table, generally possible elsewhere, are here nearly always impossible.

97. The season on the whole was a healthy one, and most of the country worked over, as expected, was comparatively dry and healthy. The establish-

BURMA SURVEY.

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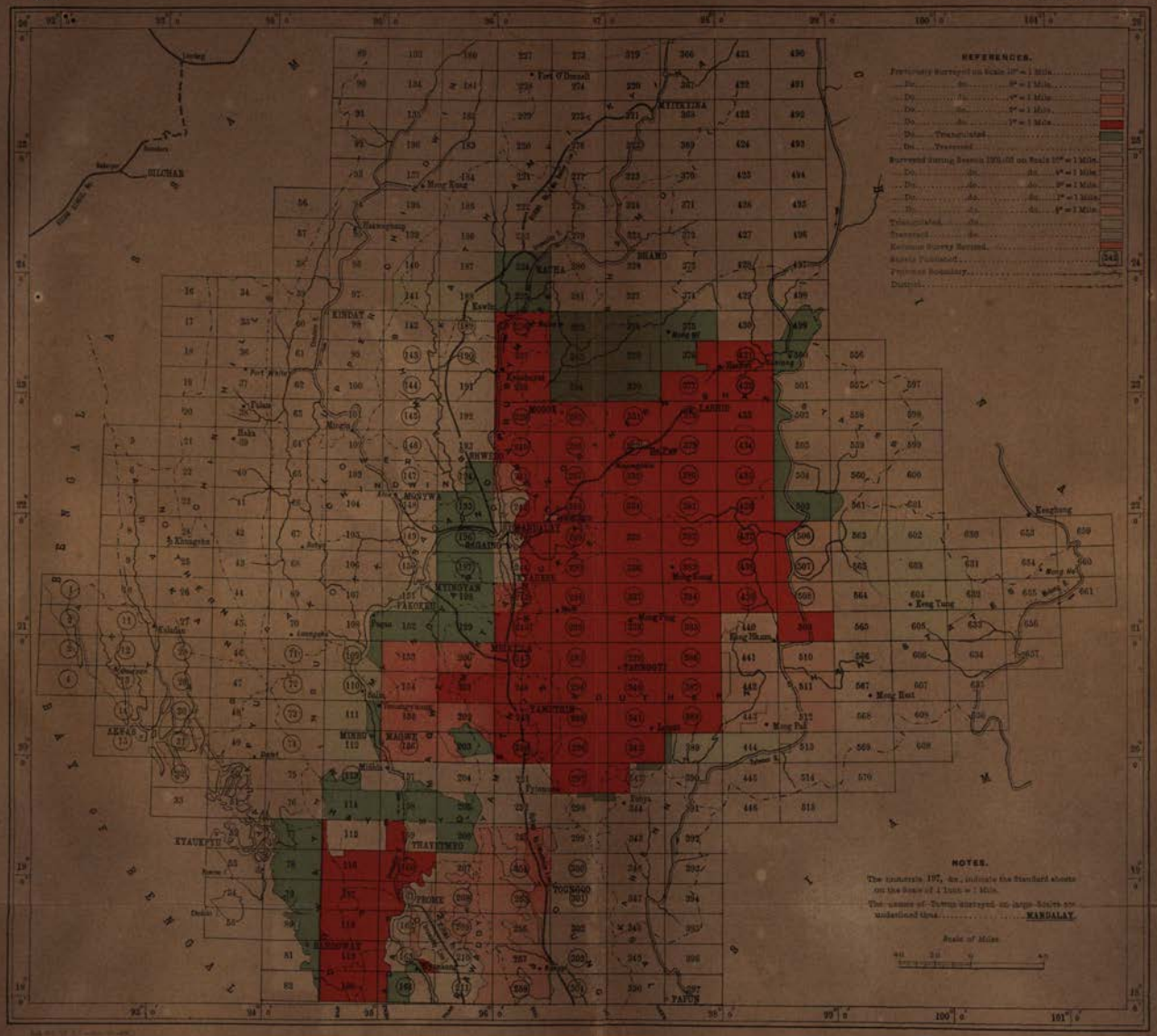
1901 02.

TOPOGRAPHICAL SURVEYS.



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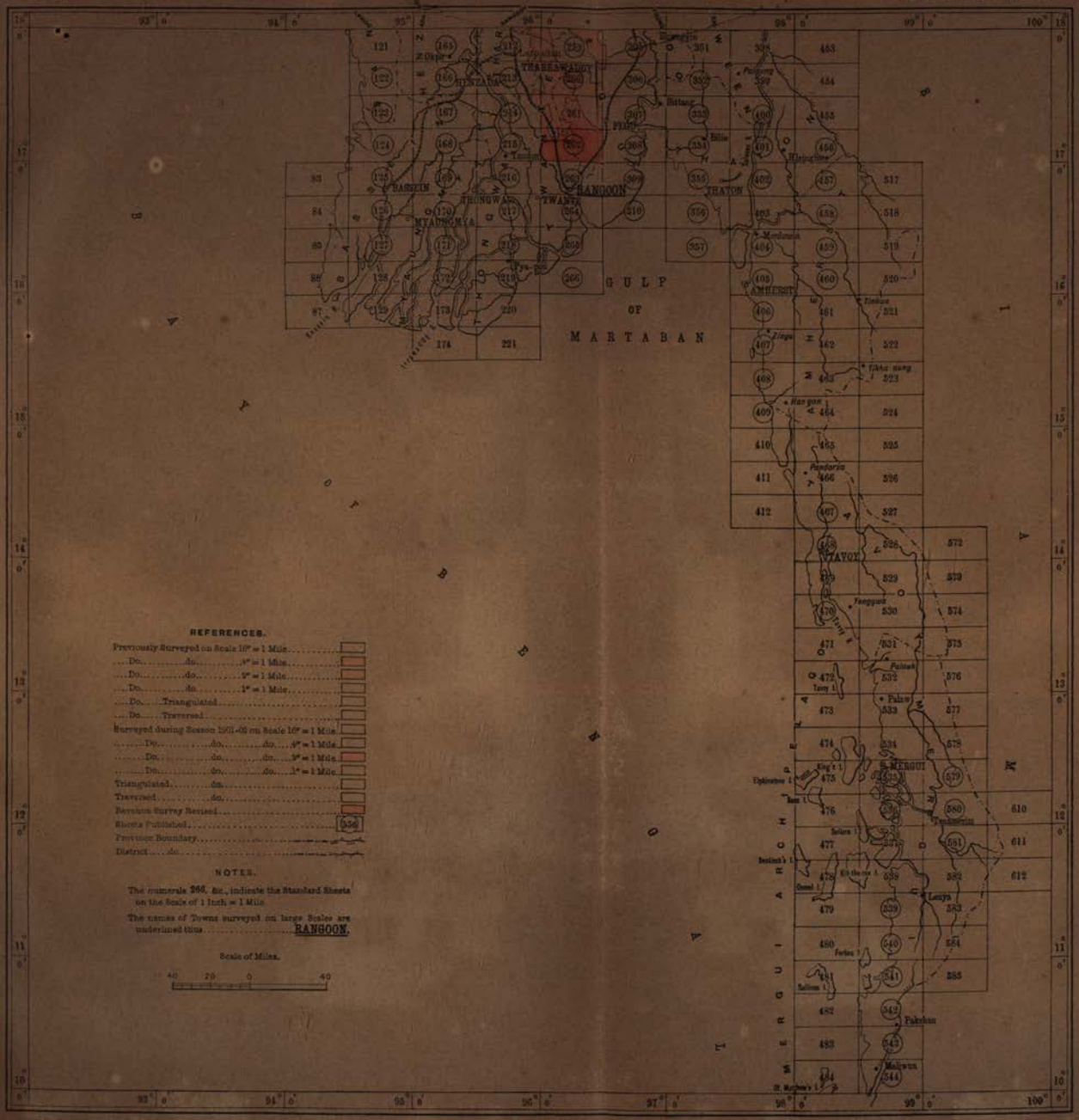
BURMA SURVEY.

INDEX TO THE SURVEY OPERATIONS IN BURMA SOUTH OF LAT. 18°.

1901-02. TOPOGRAPHICAL SURVEYS.



REFERENCES.

Previously Surveyed on Scale 16" = 1 Mile.
Do. do. 8" = 1 Mile.
Do. do. 4" = 1 Mile.
Do. do. 2" = 1 Mile.
Do. Triangulated.
Do. Traversed.
Surveyed during Season 1901-02 on Scale 16" = 1 Mile.
Do. do. do. 8" = 1 Mile.
Do. do. do. 4" = 1 Mile.
Do. do. do. 2" = 1 Mile.
Triangulated. do.
Traversed. do.
Revision Survey Revised.
Sheets Published. 256
Province Boundary.
District do.

NOTES.

The numerals 266, &c., indicate the Standard Sheets on the Scale of 1 Inch = 1 Mile.

The names of Towns surveyed on large Scales are underlined thus RANGOON.

Scale of Miles.

40 20 0 40

ment suffered somewhat in the early part of the season particularly in Wanetchoung in the Hanthawaddy district, in the Mindôn Valley of Thayetmyo district and in the Toungoo district. From Wanetchoung one of the sub-surveyors was sent back to India early in January and the party lost his services for the remainder of the season. The Toungoo detachment suffered most; one sub-surveyor was ill throughout the season and all the men were in hospital at one time or another. As proposed in paragraph 89 of last year's report the medical authorities in Lower Burma were consulted with a view to ascertaining the earliest date on which it may be considered safe to take the field. From the replies received it appears that the date both of taking and of closing the field will vary with the locality in which it is proposed to work. Several precautions are recommended such as extra clothing, the use of mosquito nets, boiled drinking water and daily doses of quinine, nearly all of which, in the case of a large establishment widely scattered without close and continuous personal supervision, it is impossible to adopt. Every precaution, however, will be taken to protect the establishment from unnecessary risks. Experience seems to confirm the view that, except perhaps in the dry zone, the health of the party will be good or bad according as the time is late or early at which it takes the field. As a part of the area to be surveyed in 1902-03 is low and swampy it is proposed to take the field this year a month later than usual.

98. In Toungoo district the ground surveyed lies between Latitude $\frac{18°47'}{19°30'}$ and Longitude $\frac{96°5'}{96°30}$ and is composed of low hills of an average height of about 700 feet, and the streams, which all contain water, have generally a very gradual fall. It is occupied by a few *Karens* whose chief occupation is that of *taung-ya* (hill cultivation). Their camps consist of a few bamboo huts which are removed every year to the new area to be cleared and cultivated. The deserted areas are immediately overgrown with a dense crop of bamboos. Most of the big trees have been removed or destroyed and are replaced by bamboos on the hills and tall grass on the flat river banks. But there are still fairly large areas of evergreen forest with a close undergrowth of shrubs, cane and creepers. Owing to this and to the quantity of water the climate is moist and unhealthy. Many of the sandstone boulders contain minute fossil shells.

In the Pegu and Hanthawaddy districts the country surveyed lies between latitude $\frac{17°7'}{17°30}$ and longitude $\frac{96°0'}{96°30}$, and is all hilly except in the valley of the *Nagamoyeik* creek, the banks of which are occupied by several large villages with extensive paddy fields. This creek lower down is known as the *Pazundaung* creek. The average height of hills is about 350 feet above sea level. They are not so thickly wooded as those in last year's work. In the whole area surveyed this year there are only two trigonometrical points owing to the uniform level of the hills. Consequently, as in previous seasons, the contours do not represent any fixed vertical interval. The work is based entirely on the traversing executed by the Revenue Survey and by No. 20 Party supplemented by a little done by this party. As the traversing of the first two parties was done several years ago, most of the stations had disappeared; but a sufficient number were found, by chaining along the old lines (a slow process), to enable the work to be done.

In the Thayetmyo district the area surveyed completed standard sheets 115, 159 and 207 and a little of 206. A description of the country has been given before and need not be repeated. The survey was based partly on traversing done by No. 20 Party, but chiefly on the triangulation executed by this party in 1899-1900.

99. The drawing of the standard sheets has made satisfactory progress this year but is still in arrears. Sheets 259, 260 and 261, are nearly ready for the press. These have been drawn in one colour for reduction to the 1-inch scale; sheet 262, of which the survey was completed this year, will be compiled and drawn in the Calcutta Drawing Office. Of the Toungoo 1-inch survey, sheet 253 will be drawn and compiled in Calcutta, and sheet 254 is in hand, but it is improbable that it will be completed this year and 255 is not taken in hand. Of the other 1-inch standard sheets 160, 161 and 162 are in the press; 117, 118, 119 and 120 are complete and under examination; 115 and 163 are in hand and will be finished by the end of the recess, 159 too is in hand but will probably not be finished.

100. The programme for 1902-03 is as follows:—

(*a*) The triangulation and traversing of the unsurveyed areas in sheets 211 to 215, 164, 165 and 166.

(*b*) The detail survey on the 1-inch scale of the unsurveyed areas in sheets 205, 206, 164, 165, 166, 211, 212, 213, 214, 215.

(*c*) The topographical revision of the cadastral and provincially surveyed areas in sheets 204, 205, 206, 211 to 215 and 164, 165, 166. This involves a certain amount of triangulation to be undertaken expressly for the revision.

101. The party was inspected in the field by Major Burrard, officiating Deputy Surveyor-General in the Thayetmyo, Prome and Hanthawaddy districts between the 17th and 26th February, and at Bangalore by Major Longe, Officiating Surveyor-General, and Major Bythell, officiating Deputy Surveyor-General, between the 30th August and 4th September. Major Gordon, Superintendent, Forest Surveys, visited the office at the same time.

UPPER BURMA.

No. 10 Party.

102. Captain F. W. Pirrie, I.A., was in charge up to the 6th June 1902, when he proceeded on leave and Lieutenant A. A. Mc.Harg, R.E., held charge of the party for the remainder of the year.

103. The party left recess quarters at Bangalore for the field on the 13th November and had all left Mandalay (the field base) for their ground by 24th November 1901.

The survey operations were of the same nature as those carried out in the previous year and consisted in revising the topographical detail on the 1-inch reductions which have been made from cadastral surveys in the Meiktila, Magwe, Myingyan, Yamèthin and Minbu districts and completing the sheets as topographical maps.

The officer in charge and his senior assistants thoroughly tested on the ground the work of the surveyors employed on revision survey.

104. The outturn for the field season was as follows:—

	Square miles.
Triangulation	3,842
Revision survey	4,100
Maymyo revision survey	19·18

The cost-rates per square mile were as follows:—

	R a. p.
Triangulation	10 12 0
Revision survey	14 5 9

105. Triangulation was carried out in the Minbu, Myingyan, Pakôkku, Magwe, Katha and Upper Chindwin districts. The revision survey comprised an area of 4,100 square miles and includes standard sheets 153, 154, 155, 156, 200, and parts of sheets 202, 203, 241, and 245.

Owing to the very intersected and cut-up nature of the country as well as to the very large amount of scrub-jungle, a great deal of care and supervision was necessary in carrying out the work.

106. The area surveyed this year is slightly larger than that of last year, but this is accounted for by the fact that no new detail survey was taken up this year and the whole of the survey was revision work, whereas last year the work was partly new survey and partly revision.

107. On the completion of the work in the field two detachments of four sub-surveyors, each under two Provincial officers, were formed for the purpose of revising and bringing up to date the Maymyo City survey. This was completed in about a month. The party left Maymyo on the 6th June for recess quarters at Bangalore.

108. The health of the party in the field was fair. One soldier-surveyor suffered from fever throughout the field season and had to be sent on 6 months'

sick leave before the party left the field. Two other sub-surveyors were obliged to proceed on 3 and 6 months' sick leave from recess. There were some cases of fever and dysentery among the menials. Three deaths occurred and one man was drowned.

109. During recess the computations of those portions of the triangulation required for next season's work were completed. Standard sheets 153, 154, 155, 156, 200, 201, 248, 296, were completed and sent to Calcutta for publication, while the data for fair drawing standard sheet 241 were sent to the Calcutta Drawing office.

110. The programme for the next field season is as follows :—

The triangulation of standard sheets 145, 146, 149, 150, 192, 193, and 194 and the completion of the secondary series connecting the Great Trigonometrical Mandalay meridional series near Katha with the secondary Great Trigonometrical Manipur meridional series near Kindat for the future extension of topographical triangulation and to provide stations and points for the Forest survey traverses between those Great Trigonometrical series.

As a matter of secondary importance a connection will be made with No. 14 Party's triangulation west of Fort White and other existing triangulation near Kindat.

The detail survey on the 1-inch scale, partly revision and partly new, of sheets 110, 111 and 112, 151, 198 and 199.

111. The party was inspected by the Officiating Surveyor-General during recess.

UPPER BURMA.

Nos. 11 and 21 Parties.

112. As was mentioned in last year's report, Nos. 11 and 21 Parties were amalgamated by order of Government, and Mr. P. J. Doran was in charge of the combined parties throughout the year.

113. The party left Bangalore at the end of October, and after some delay reached the scene of operations about the 15th of December, the last man taking up work about the end of that month. They returned by the end of May.

114. The country surveyed in detail on the one-inch scale was that portion of the Southern Shan States situated on the western side of the Salween river lying between latitude 20° 15′ and 21° 15′. It was for the most part very hilly and covered with jungle and was fairly populated averaging a village to every 4 miles. The cultivation, mostly *taung-ya* (hill cultivation) producing sufficient for local consumption both in cereals and vegetables. Oranges and limes are plentiful and trade in them is brisk for two or three months of the year.

115. The work completed during the season under report is—

	Sq. miles.
Triangulation for 1-inch scale survey	1,489
" " ½ " " "	3,740
Detail survey on the 1-inch scale	2,663
" " " ½ " "	2,561

The cost-rates per square mile were as follows :—

	R	a.	p.
Triangulation for 1-inch scale survey	10	6	9
" " ½ " " "	2	2	8
Detail survey on the 1-inch scale survey	23	4	2
" " " ½ " " "	3	1	4

The area surveyed on the one-inch scale comprises sheets 440 to 443 and the ground to the west of the Salween river in sheets 510 to 512, and on the quarter-inch scale, the ground to the east of the Salween in sheets 506 to 508 and 510 to 512.

The country triangulated for the one-inch scale lying in sheets 389, 443, 444 and 513, in its natural features resembled much the ground surveyed in detail. The hills are higher and the low ground very broken, all covered with dense jungle—the low ground particularly being overgrown with brushwood and high grass.

The work, both topography and triangulation, is very satisfactory considering the obstacles and difficulties which had to be overcome.

116. The loss of time owing to the detention for 12 days on account of a suspected case of plague has contributed somewhat to raising the cost which is slightly higher for the one-inch detail survey this year than that of last year.

117. The work was rigidly tested and the men were constantly visited during the season. Difficulties were solved with the surveyors present and their errors shown them on the spot. The work has proved very good.

118. During the recess the party has completed the fair drawing for publication in two colours of all the one-inch work surveyed during the season. The computation of the triangulation has also been finished and the results are satisfactory. The only arrears consist of the triangulation charts of the parties, and these are being pushed on so as to be out of hand as quickly as possible.

The health of the party was not so good as in previous years; there were several cases of fever and dysentery, some very sudden and severe. There was one death among the menials.

119. The following programme has been sanctioned for the coming season:—

Detail one-inch survey of sheets Nos. 389, 444 and the country falling to the east of the Salween river in sheets Nos. 510 to 512.

Triangulation in sheets 513, 567 and 568 and in portions of 569 and 609 up to the Shan-Siam boundary.

120. The party was inspected by the officiating Surveyor-General on 28th and 29th August 1902, who expressed his satisfaction at the state of the work.

SIND.

No. 12 PARTY.

121. The operations during the year under report were in continuation of those of the previous season, Mr. C. F. Erskine remaining in charge of the party.

122. The following programme was completed:—

(*a*) Net work of secondary triangulation in two blocks, one covering the whole of the desert of the Khairpur State lying west of the Nára river, and the other covering the desert in the Shikárpur district.

(*b*) Village boundary traverse survey in portions of sheets Nos. 41, 42, 43, 44, 45 and 46, together with area of about 300 square miles in the Khairpur State, where the village boundaries are not demarcated.

(*c*) The detail survey on the 2-inch scale of portions of sheets Nos. 41, 42, 43, 44, 61, 62, 63, 64, 65, 80, 81, 82 and 83.

(*d*) The detail survey on ½-inch scale of the whole of the desert of the Khairpur State was also completed.

123. The recess office at Kurrachee was closed on the 30th October 1901, and the party assembled at Ránipur on the 5th November.

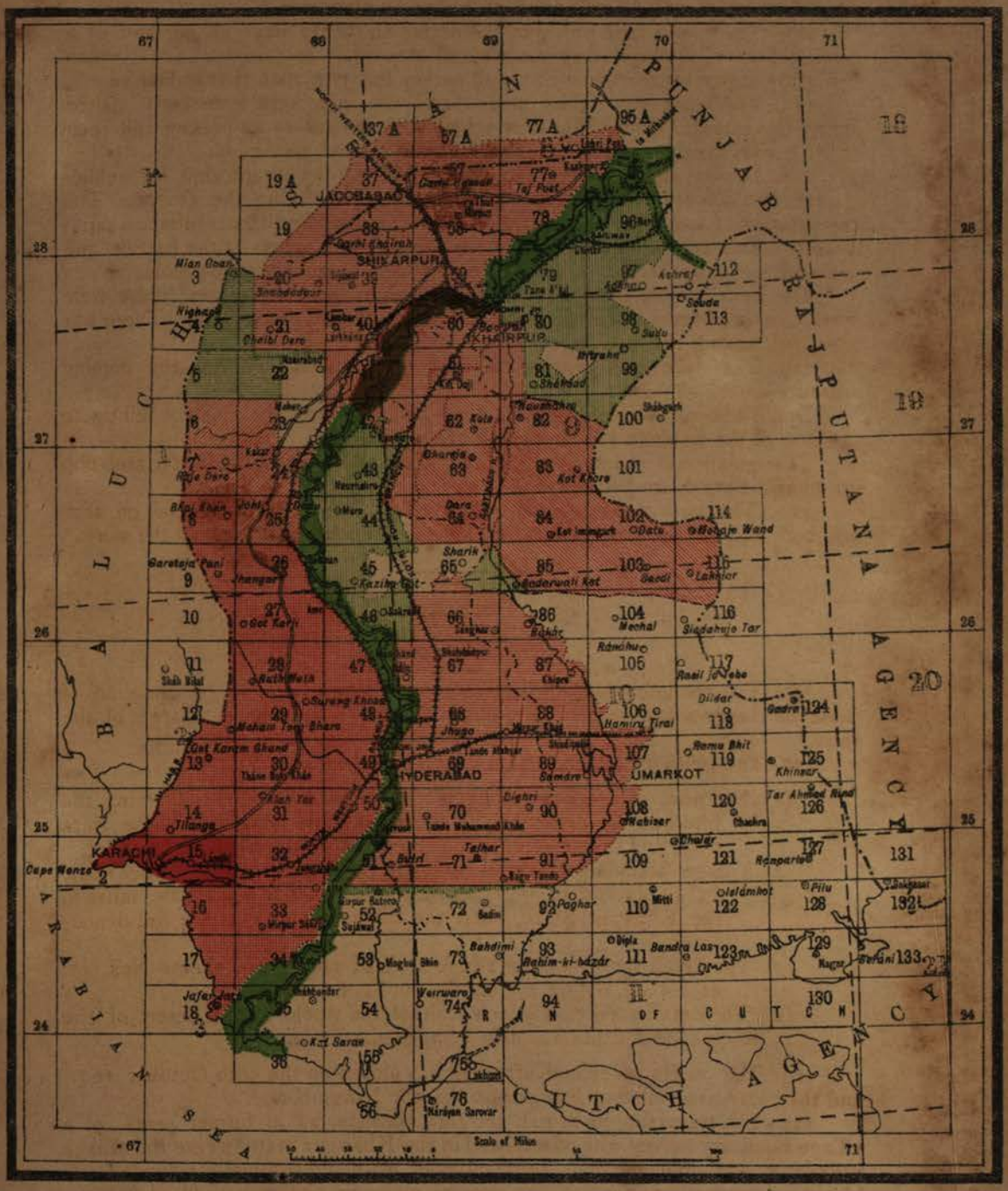
124. The traversing in British territory consists, as in former years, of a village boundary survey with offsets, and in the Khairpur State, where the village boundaries are undemarcated, of a series of main and sub-circuits divided into blocks by connecting lines. There were 7¾ main circuits measured, 9 sub-circuits and 334 village circuits.

The angular work was checked by observations for azimuth at 60 stations on main and sub-circuits, the average angular error per station being ·34″. The linear measurements amounted to 2,125 miles, and were checked by 17 connections with the stations of the minor triangulation executed by this party and with some stations of the Sehwan secondary series.

The average correction per 1,000 links was 0·4 link. No permanent marks were laid down at traverse stations but the marks erected by the revenue authorities to demarcate village boundaries have been utilized, and the angles of village boundaries have been fixed by offsets. In addition to the foregoing traverse operations 34 bench marks laid down by the Railway Department were

SIND SURVEY.

1901-1902 Nos. 12 and 15 PARTIES



Regt. No. D. 58, S. I. D. - Aug. 1902 - 250

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, September 1902.

REFERENCES.

Surveyed in previous Seasons Scale 1" = 1 Mile by No. 12 Party

Do. do. 2" = 1 Mile do.

Do. do. 4" = 1 Mile do.

Do. 1901-1902 2" = 1 Mile do.

Do. do. ½" = 1 Mile do.

Triangulated and Traversed in advance do.

Surveyed in previous Seasons Scale 1" = 1 Mile by No. 12 Party

Do. 1901-1902 1" = 1 Mile do.

Triangulated in advance do.

Indus Riverain Survey

NOTES.

The numerals 63, etc., indicate the Standard sheets on the Scale 1 Inch = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

NO. 385-S. 02.

UNITED PROVINCES OF AGRA & OUDH.

1901-02. INDEX TO THE TRAVERSE SURVEY IN THE U. P. A. & OUDH. Nos. 2 & 8 & 14 PARTIES.

connected with the traversing; this involved observations at 36 stations and 20¾ miles of chain measurement. The cost of the traverse survey amounts to R14·9 per square mile.

125. The area surveyed in detail on the 2-inch scale amounts to 1,597 square miles, giving 56 plane-table sections. The survey was carried out entirely by interpolation with the exception of a strip on either bank of the Nára river where owing to the density of *babul* jungle the chain had to be freely used; it was tested from 1,150 *in situ* fixings, and was carried out under the direct supervision of the officer in charge. The cost of detail survey is R17 per square mile.

126. The survey of the desert of the Khairpur State on ½-inch scale was completed during the field season. The area surveyed amounts to 4,556 square miles, giving 14 plane-table sections.

The survey was carried out entirely by interpolation, it was tested from 329 *in situ* fixings. The cost of the survey is R3-1-0 per square mile.

127. Field work closed by the end of March and the party returned to Kurrachee for recess. During recess the fair mapping of the entire area surveyed in detail on the 2-inch scale was completed.

The mapping comprised 32 quarter sections. They were drawn on the 2-inch scale for reduction and have all been despatched to the Trigonometrical Office, Dehra Dún, for publication. The fair maps of ½-inch work are all in hand and will be sent to Dehra Dún on the completion of drawing for reproduction and publication.

The triangulation and traverse charts of sheets 41, 42, 43, 61, 62, 63, 64, 80, 81, 82, 97, 98, 99, 100, 101, 102, 112 and 113 have been drawn. All the charts with the lists of co-ordinates have been despatched to Dehra Dún.

128. Next season's triangulation and traversing in advance will be taken up in sheets 34, 35, 36, 45, 52, 53, 54, 55, 56, 65, 72, 73, 74, 75, 76, 92, 93 and 94.

Detail survey will be carried on in sheets Nos. 24, 25, 26, 42, 43, 44, 45, 46, 78, 79, 80, 81, 82, 95, 96, 97, 98, 99, 100, 112 and 113.

129. The party was inspected by the Superintendent, Trigonometrical Surveys.

UNITED PROVINCES OF AGRA AND OUDH.

No. 14 PARTY.

130. In October 1901 this party was transferred from the Lushai hills to commence the topographical survey of districts Allahabad, Fatehpur and Cawnpore on the scale of 2 inches = 1 mile, and was placed under the charge of Mr. R. B. Smart, who handed over to Captain C. W. H. Symonds on his return from furlough on the 20th March 1902. The former retired on superannuation pension on 28th June 1902.

131. The party assembled at Allahabad on the 25th October. Owing to the hostile attitude of the people (arising from their superstitions regarding plague) it was found advisable, in consultation with the Collector of Allahabad, to close the field work on the 1st April and return to recess quarters at Mussooree, where the office was opened on the 17th April.

It was decided that the traverse survey should be of such a permanent nature that it might be utilized not only as a basis for the topographical survey, but also for any cadastral survey which, at some future date, may be initiated by the Government of the United Provinces of Agra and Oudh.

132. The following statement gives a summary of the work done and the cost-rates:—

DISTRICT ALLAHABAD.

DEMARCATION.		TRAVERSING.		TOPOGRAPHICAL SURVEY 2-INCH = 1 MILE SCALE.	
Square miles.	Cost per square mile.	Square miles.	Cost per square mile.	Square miles.	Cost per square mile.
2,066	R a. p. 3 2 2	1,988	R a. p. 30 2 10	203	R a. p. 16 6 10

133. The area traversed consisted of the whole of the Allahabad district with the exception of a portion of *tahsil* Karchana and the whole of *tahsil* Meja. The traverse of these latter areas and of Allahabad city was abandoned owing to the prevalence of plague.

The origin of survey adopted was $\frac{\text{Latitude } 25^\circ\ 15'\ 0''}{\text{Longitude } 81^\circ\ 45'\ 0''}$ and observations for azimuth were made at 308 stations. The average correction applied to the angular work was + 1 minute in 12 angles and — 1 minute in 17 angles. Connections were made to 9 stations of the Gurwáni and the Karára meridional series, the resulting error per linear mile being 2·3 feet. On comparing the direct distance according to the Great Trigonometrical Survey and that arrived at by traverse between Ganeshpur, a trigonometrical station of the Gurwáni meridional series, and Singraur of the Karára meridional series it was found that the error per mile in a distance of 33·1 miles was as small as +0·21 of a foot.

134. The area traversed, namely, 1,988 square miles, was divided up into 8 main circuits and 7 river blocks; this was again subdivided into 87 sub-circuits. The above area contained 3,030 villages.

In order to facilitate a cadastral survey on the 16-inch scale, should one be taken up at some future date, 1,488 sub-traverses were run. The stations were marked as follows:—

Stones	14,799
Cylinders	12,878
Pakka trijunction points	4,511
Pegs	332
Pakka pillars	1,731
	34,251

In order to ensure the permanency of the demarcation, stones were embedded at each trijunction and also at the end of each *jawáb* station. Further, when trijunction points were more than a mile apart, two stones, at a convenient distance apart, were embedded on the boundary of the village. During the coming field season it is in contemplation to embed stones at the starting and closing points of all sub-traverses, and when these are a mile or more apart, 2 stones on every mile of sub-traverse. This will undoubtedly ensure the permanency of the traverse survey, but will considerably raise the cost-rates. In Government of India letter, No. 730 of 9th May 1902, it was decided that the actual cost of demarcation will be chargeable to Provincial Revenues.

All the traverse computations have been completed together with the computations of secondary triangulation and intersected points which remained in arrears when this party was transferred from the Lushai hills. There are now no arrears.

135. The area topographically surveyed on the 2-inch scale was carried out by a small establishment of 4 men. The area completed amounted to 203 square miles. The outturn is small, but this is accounted for by the fact that no traverse data were available until the end of December 1901. The above area of 203 square miles is mapped on 7 plane-tables, which contained 101 plane-table fixings per square mile. The work was tested by 56·96 linear miles of test lines.

136. The country traversed is for the most part flat and highly cultivated. In the southern portion of the district, where it touches the Rewah State, the ground is broken, and for this reason the chaining was considerably impeded.

137. The health of the establishment throughout the field season was excellent in spite of plague. One menial died of dysentery.

138. The programme for the ensuing field season is as follows:—

(1) Traverse of about 2,000 square miles in districts Allahabad and Fatehpur.

(2) Topographical Survey on the 2-inch scale of about 2,000 square miles in Allahabad district.

(3) Survey of Allahabad cantonment on the scale of 12 inches = 1 mile, and the *bazars* on the scale of 100 feet = 1 inch.

139. The party was inspected by the officiating Deputy Surveyor-General at Allahabad on 9th November 1901 and by the officiating Surveyor-General at Mussooree on the 5th August 1902.

NORTH-WEST FRONTIER.

No. 15 Party.

140. Mr. E. A. Wainright held charge of the party during the year under report. Captain G. A. Beazeley, who had been attached to the party, was transferred to the charge of No. 18 Party and Lieutenant A. A. Crookshank proceeded on six months' sick leave.

141. The party was divided into the following detachments:—

1. Kashmir and Gilgit Agency under Mr. H. C. H. Cooper.
2. Frontier work under Lieutenant A. A. Crookshank, R.E.
3. Cantonment surveys under Mr. McHatton.
4. Sind and other surveys under Mr. G. A. Knight.
5. Settlement traversing in Balúchistán under Ahmed Ali Khan, K.B.

Besides these detachments, several members of the party were from time to time employed on special work.

142. The programme submitted in last year's report has been fully carried out. In Kashmir a further total of 2,786 square miles of ½-inch topography was added in sheets 41 and 46 of the Trans-Frontier standard sheets, including a revision survey undertaken in sheet 43. The Khágan sheets are also being revised to admit of including this work with that of the present Kashmir survey in sheet 39 now being drawn for publication, and some triangulation was carried out by Mr. Cooper in the Khágan valley. The cantonment and bazars of Cawnpore, Jhánsi, Nowgong, Bareilly, Lucknow, Agra, Meerut and Fatehgarh have been completed. In Sind the 1-inch topography of sheets 6, 7, 23-W., 24 and 25 was completed, as also the triangulation of sheets 3, 4, 5, 21-W, 22-W. The traversing for settlement surveys in Balúchistán was carried on as before.

143. In the summer of 1901, Captain Beazeley, who was triangulating in Kashmir, was instructed to make a survey of the Satshe Glacier near Astor, using a Bridges-Lee photo-theodolite instead of a plane-table. He first triangulated the ground and then took the necessary photographs, subsequently plotting the map at Mussooree.

The result, as illustrating the value of the method, is by no means a success; the operation of plotting from the photographs was a most lengthy and laborious work, and when finished, in many ways fell far short of a plane-table survey which would have been completed in one-tenth of the time. Many features, such as huts and paths among the hills, did not show at all in the photographs, and so are entirely omitted from the resulting map. This is not the fault of the surveyor but of the system.

144. During the year a large amount of fair drawing has been got through. The fair drawing of the cantonment and bazar plans of Nowgong, Bareilly and Jhánsi are ready, and during the winter months the drawing of these surveys will be brought up to date. The fair mapping of Sind sheets is well in hand and by the end of the year it is hoped there will be no arrears of drawing with the exception of the Kashmir sheets. The computations of cantonment traverses have been checked and bound in volumes and the Sind triangulation computed and ready for this season's plane-tabling.

145. The total outturn of the party is as follows:—

	Sq. miles.
Triangulation in Kashmir	183
" " Sind	1,215
" " Balúchistán	54
Detail survey ½-inch	60,450
" ¼ "	5,151
" ⅛ "	2,787
" 1 "	1,696
	Acres.
Cantonment surveys 12-inch	26,095
" " 48 "	846
" " 60 "	119

146. The party lost several *khalasis* from dysentery and fever, and the health of the Sind detachment was bad throughout the winter.

147. The programme for the ensuing year includes the continuation and completion of the 1-inch topography in Sind contained in sheets 3, 4, 5, 20-W., 21 W., 22 and 23-W., and the large scale plans of Chakráta, Umballa, Meean-Meer, Pesháwar, Ferozepore and Mooltan are to be undertaken. As the demand for the cantonment surveys under the new Cantonment Act is a much larger one than had been expected, it has been determined to temporarily postpone further work in Kashmir and concentrate the strength of the party as much as possible on the cantonment surveys.

148. The recess office of the party was inspected by the officiating Surveyor-General.

PUNJAB.

No. 18 PARTY.

149. Lieutenant A. A. McHarg, R.E., was in charge of the party at the commencement of the year under report, until the 28th October, when Major W. J. Bythell, R.E., rejoined from a month's privilege leave. Major Bythell retained charge until the 13th May 1902, when on appointment as Officiating Deputy Surveyor-General he handed over charge to Captain G. A. Beazeley, R.E., who retained it until the close of the year. Lieutenants R. H. Thomas, R.E., and L. C. Thuillier, I.A., were attached to the party from the 9th April until the 6th August 1902, and during this period they underwent a course of instruction in 2-inch plane-tabling in the Simla Hill States.

150. The work of the party was considerably changed from the purely topographical operations which had hitherto formed its programme. In general terms, the new work of the party may be briefly described as follows:—

(1) The utilization of the existing large scale *patwaris'* maps to form one inch topographical maps by a process of compilation and revision in the field.

(2) The execution of riverain surveys in order to allow of the determination of riverain boundaries at any future time.

In carrying out the first of these, the system formerly carried out by No. 1 Party between the years 1884-89 in the Punjab plains was reverted to. In this system, traverses are run over the district connecting the trijunctions of villages and the marked ends of village base lines. These trijunctions and base lines are then plotted on to plane-table sheets on the 2-inch scale. The *patwaris'* maps on the 24-inch are then reduced by pantograph to the 2-inch scale and the reduced maps fitted village by village on to the plotted plane-table sheets, being adjusted in proper position by means of the trijunctions and base lines already plotted.

These plane-table sections are then examined in the field, if necessary corrected and any topographical detail added which may have been omitted from the *patwaris'* maps.

From these plane-table sheets standard sheets are drawn on the 2-inch scale for reduction and publication on the 1-inch scale.

151. On the abolition of No. 1 Party in 1890, the following seven districts had been already traversed and were ready for map revision:—

Lahore.	Siálkot.
Amritsar.	Gujrát.
Gurdáspur.	Gujránwála.

Shahpur (plains portion).

As mentioned in paragraphs 292-294 of last year's General Report, traversing was completed by the Punjab traverse detachment in the Gugera and Dipálpur and a portion of the Pákpattan *tahsils* of the Montgomery district and field sections had been prepared from the traverses. It was therefore determined to commence the revision survey in the Montgomery district.

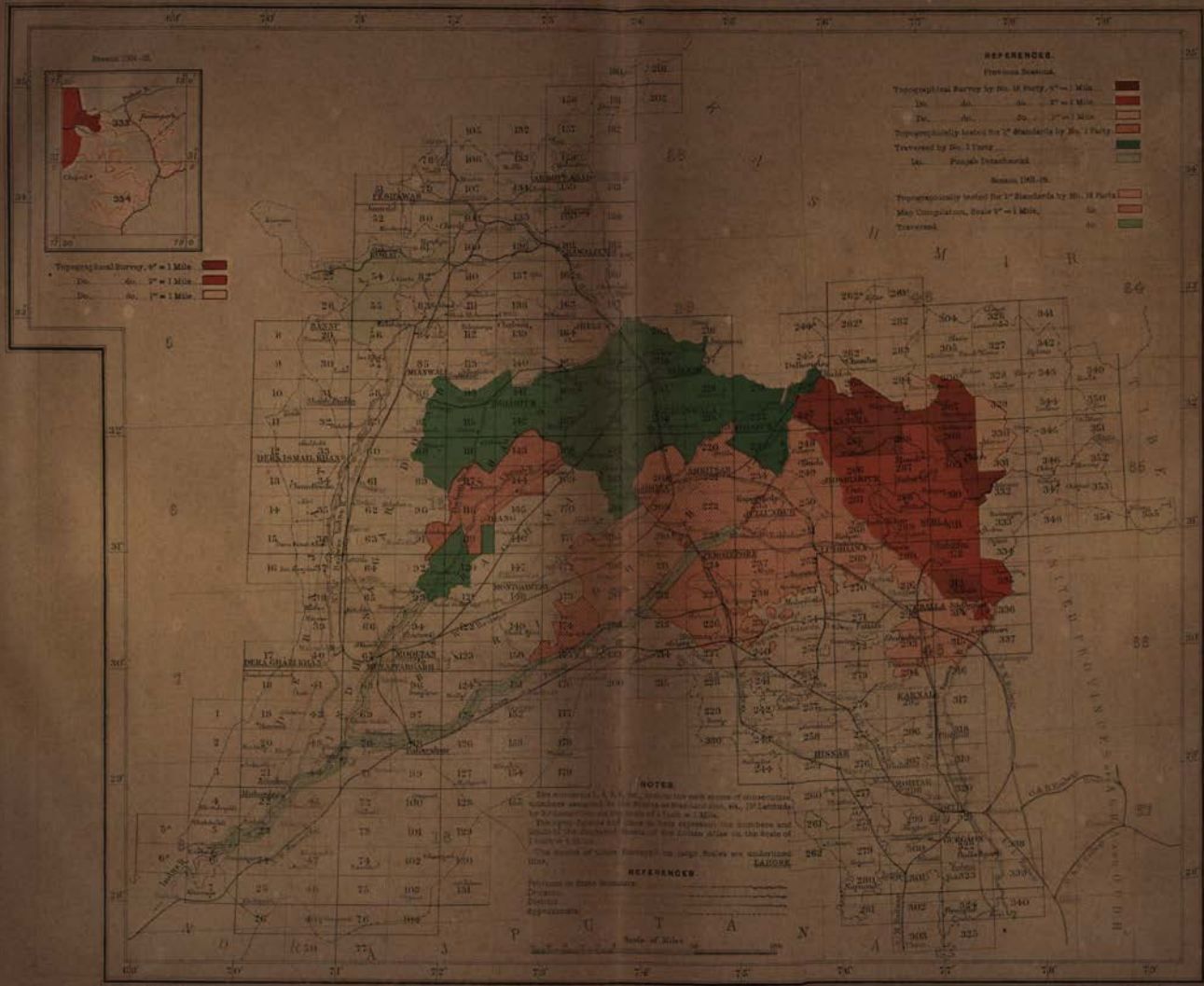
This portion of the field work, *viz.*, the testing in the field, and insertion, of all topographical details on the reduced and congregated *patwaris'* maps was successfully carried out, in the Gugera and Dipálpur *tahsils* of

PUNJAB & N. W. FRONTIER PROVINCE SURVEY.

1901-02.

INDEX TO THE SURVEY OPERATIONS IN THE PUNJAB & N. W. FRONTIER PROVINCE.

No. 18 PARTY.



Montgomery and the Chunián *tahsil* of Lahore over an area of 3,000 square miles by a detachment of 11 plane-tablers under the charge of a Provincial officer. This detachment was at work in the field from the 15th November 1901 until the 20th April 1902.

152. The traverse work of the party, in preparation for future revision work, consisted of the completion of the traversing in the Pákpattan *tahsil* of the Montgomery district, which had been commenced the year before by the Punjab traverse detachment. This work was completed by nine traversers under the charge of a Provincial officer by the end of December 1901, and comprised an area of 188 square miles.

153. *Riverain Surveys.*—For the execution of these, traverses are to be run along the high banks of certain selected rivers with a view to the preparation of riverain maps showing the district boundaries which lie in the river beds, and from which maps, the correct position of any district boundary mark or trijunction which might be washed away, could at any subsequent time be redetermined.

On this work 11 traversers were employed under a Provincial officer. The portion completed with a main traverse on either high bank, well removed from any river action, extended from the Lahore-Amritsar boundary on the Sutlej, down that river, and the rivers Chenab and Indus to the Sind boundary on the last, a distance of 815½ linear miles in which 852 dressed stones were embedded, and connections were made with ten principal and two secondary stations of the Sutlej series, two principal stations of both the Gurhágarh and Jogí Tíla series and with five principal stations of the Great Indus series. The traverse on the left bank of the Sutlej in the Bahawalpur State, opposite the Montgomery district, was not completed as the settlement was still proceeding in the State and no maps were available.

The Drawing section of 14 draftsmen under a Provincial officer remained in Simla during the field season.

Thirty-four sheets, of which 10 were on the 4-inch scale, 21 on the 2-inch and 3 on the 1-inch, were sent for publication during the year. It is satisfactory to be able to report that all the arrears of mapping have been cleared off with the exception of one sheet, whilst all the mapping of the area topographically tested in the Montgomery and Lahore districts has been completed during recess by the field hands. This area of 3,000 square miles has been mapped in thirty-four 2-inch sheets, of which 16 comprising five 1-inch standard sheets will be sent for publication. The remaining sheets must be held over for completion to margin during the coming field season.

154. The topographical work carried out during the year consisted of 4-inch, 2-inch and 1-inch surveys in the Kot Khái *ilaka*, Kumhársain and Jubbal, Balsan, Tarhoch, and other Native Hill States, and small portions in Tehri-Garhwál, comprised in sheets 333 and 334. This was completed by a small detachment consisting of Lieutenants Thomas, R.E., and Thuillier, I.A., and 4 plane-tablers.

155. The total outturn of the field season's work amounts to the following:—

		Square miles.
1. Topography	4-inch scale	23
	2 „ „	43
	1 „ „	255
		Linear miles.
2. Traversing		2,406
		Square miles.
3. Map revision		3,000
4. Preparation of field sheets for revision survey		5,210

156. The cost-rate of each description of work per square mile is as follows:—

	R
Detail survey on 4-inch scale	74·3
„ „ „ 2 „ „	53·7
„ „ „ 1 „ „	10·1
Traversing	28·3
Map revision	6·9
Preparation of field sheets for revision survey	2·0

157. *Simla Survey.*—The actual traversing in connection with this work has been completed during the year. A small amount of supplementary triangulation was found necessary to facilitate the traversing of the exterior boundary, 15 stations and 21 intersected and bar subtense points having been fixed. The survey of the exterior boundary of 250 estates, 4 sub-traverses and 30 village or "settled-area" blocks was completed by the end of August. All that now remains is the actual testing of the work in the field by means of the plane-table. This work is now in progress and provided the winter is not exceptionally severe should be completed by March next. As each sheet is checked, a trace thereof is made on bank-post paper which will be ready for reproduction by the Vandyke process after the estate names and numbers have been typed on it.

158. The programme for next field season comprises the following :—

(1) The preparation of Mooltan district for map revision. This implies that either the district will have to be freshly traversed, or the old traverse data of 1854-58 will be utilized as a basis on which to plot the reductions of the *patwaris'* maps. Every effort will be made to utilize these old traverses, but without trial in the field it is impossible to decide definitely, as the matter rests on whether the old trijunction marks of the traverse survey can be identified on the ground or not.

(2) The examination and correction in the field of the reduced *patwaris'* maps on 2-inch sections to complete the Montgomery, Lahore and Amritsar districts.

(3) Riverain survey or preliminary traverse along both banks of the river Indus, working northwards from its junction with the Chenab and completing as large an area as possible during the field season.

159. The office of the party was inspected by the Officiating Surveyor-General and Officiating Deputy Surveyor-General on 5th, 15th and by the Officiating Surveyor-General on the 29th May 1902, and visited on occasions by the Officiating Surveyor-General during his stay in Simla.

FOREST SURVEYS.

MADRAS PRESIDENCY.

NOS. 9 AND 19 PARTIES.

160. Mr. Hugh Todd held charge of the combined parties throughout the year under report.

The parties were divided into three camps for 4-inch forest surveys as follows :—

(1) Mr. C. C. Byrne with 20 surveyors, Kurnool district (Northern Circle).
(2) Mr. G. T. Hall with 19 surveyors, Cuddapah district (Central Circle).
(3) Mr. W. F. E. Adams with 19 surveyors, South Canara district (Southern Circle).

Mr. H. A. Gibson was under training.

In addition to the above, Mr. M. J. Sheehan with 2 traversers carried out the triangulation and traversing in advance for a 16-inch survey of the Godávari delta, which it is proposed to carry out for the Irrigation Department in 1902-03. A surveyor was also lent to the Court of Wards to survey the Sivagiri zemindari forests on the 4-inch scale.

The camps left Bangalore for the field early in November and returned to their recess quarters in May.

161. The advance triangulation in the Kurnool, Cuddapah and South Canara districts was in continuation of the previous season's work and a total area of 1,680 square miles was completed. The results of the triangulation show an improvement on those of previous seasons both as regards quality and quantity and serve to prove that with due precautions, native agency can be usefully and economically utilised for this class of work. With the season under report the triangulation required for the Kurnool and Cuddapah districts

has been completed. In addition to the above area, 300 square miles were triangulated along the Godávari river in advance for the riverain survey. Most of the stations were marked by stone slabs embedded in concrete for the purpose of serving as permanent marks for future surveys which may be required to map changes in the course of the river; as these marks had to be built under the supervision of the triangulator before his observations were taken the work was tedious and costly.

162. Four hundred and fourteen linear miles of forest reserve boundaries were traversed by theodolite in the different districts under survey. The length of traverse falls considerably short of that of the previous season; this was chiefly due to the backward state of cleared lines in the South Canara districts, where in some instances clearing and traversing had to be carried on *pari passu*: the traversing of boundaries in the Kurnool and Cuddapah districts has now been completed. In addition to the above a total length of 411 linear miles in connection with the cadastral survey of the Godávari river was completed.

163. An area of 1,306 square miles of 4-inch detail survey was completed in the Kurnool, Cuddapah, Coimbatore and South Canara districts; this includes an area of 68 miles of resurvey in three districts. The area surveyed is less than for the previous season, and is partly due to the more difficult character of the Cuddapah forests, where the chain had to be more extensively used, and progress was necessarily slower, and partly to a surveyor having been lent to the Court of Wards for the survey of the Sivagiri zemindari forests which comprise an area of 37 square miles. Strict supervision and careful examination of the work while in progress ensured the detail survey being accurate and of good quality.

164. The health of the parties in the field, although better than in the previous season, was not so satisfactory as could have been wished. Malarial fever was prevalent but in many cases did not incapacitate the men until they got to Bangalore. Mr. Wilson suffered from repeated attacks of fever in North Coimbatore and had to close work before completing his work, and several members of the establishment were sent on sick leave during and after the field season. Two menials died of cholera in South Canara, one of fever in Cuddapah, and another from the result of an accident.

165. The mapping, consisting of 54 sheets, will be completed before the party again takes the field and the computations are well advanced. This, considering the many cases of fever during recess, may be considered very satisfactory. Several sheets of Cuddapah and Kurnool will have to be withheld on account of wrongly demarcated rights and boundaries. Owing to certain rights not having been pointed out to the surveyors at the time of survey and to much of the Mysore-South Canara boundary being undemarcated it will not be possible to send any of the South Canara maps to press. The maps of the North Coimbatore forests have also been withheld pending a further examination and revision of field surveys in that district.

166. The actual expenditure for the survey year ending 31st August 1902, inclusive of cost of instruments and exclusive of cost of Godávari river survey, is R91,625 as compared with R93,335 in 1900-01. The difference is accounted for by a percentage of pay and allowances of the officer in charge having been debited to the Godávari river survey, and to the pay and allowances of a surveyor on deputation having been charged to the Court of Wards, Madras. The cost of the Godávari river survey inclusive of the cost of instruments, was R7,483. The following table shows the comparative cost-rates and area surveyed for the last three years:—

Description of Work.	Area surveyed.			Cost-rates per square mile.		
	1899-1900.	1900-1901.	1901-1902.	1899-1900.	1900-1901.	1901-1902.
Triangulation (forest) . .	1,429	1,335	1,680	8	6	5
Ditto (river) . .	...	...	300	...	...	16
Traversing (forest) . .	312(*a*)	771(*a*)	414(*a*)	27(*b*)	8(*b*)	14(*b*)
Ditto (river) . .	...	...	411(*a*)	...	...	7 *b*)
Topography (forest) . .	1,524	1,378	1,306	58	58	59

(*a*) Linear miles. (*b*) Per linear mile.

The party worked under similar conditions as during last season and except in the case of traversing, the cost-rates are nearly the same. The increase in the cost of traversing was owing to extra expense in line clearing and to a smaller outturn.

167. The programme for the ensuing field season comprises the further extension of triangulation in South Canara, and a commencement in Ganjám and Godávari and for a small area in Trichinopoly; continuation of traversing of boundaries in South Canara district and commencement of the same in the districts of Ganjám and Godávari; 4-inch detail survey in Kurnool, Cuddapah and South Canara and, if practicable, in Trichinopoly; further examination and revision of work in Coimbatore (north); subsidiary traversing and cadastral survey on the 16-inch scale of a portion of the Godávari river.

168. The parties were inspected in recess by Major Longe, Officiating Surveyor-General, and by Major P. J. Gordon, Superintendent, Forest Surveys.

169. The season's field work was verified with the aid of the Government notifications by the District Forest Officers of Kurnool, Cuddapah and South Canara, who visited the office at Bangalore for the purpose.

BOMBAY PRESIDENCY.

No. 17 PARTY.

170. Mr. S. F. Norman held charge of the party from 1st October to 14th November 1901, when he was relieved by Mr. B. G. Gilbert-Cooper, who held charge throughout the field season and up to 30th June 1902, when, on his transfer to Calcutta to officiate as Assistant Surveyor-General, Mr. S. F. Norman was again appointed to the officiating charge of the party, and held it for the remainder of the year. During the year one draftsman died from plague, and two sub-surveyors from fever; one computer was also invalided.

171. The various detachments left Poona for the field during the fourth week in November, and returned to recess quarters during the first week in June, giving a full working season of six months.

172. The party was divided into three camps, under Messrs. C. A. Norman, S. F. Norman and C. J. Veale respectively, and continued the survey on the 4-inch and 8-inch scales of the forest areas in the Northern, Central and Southern Circles of the Bombay Presidency, these operations comprising—

(1) *Northern Circle.*—Supplementary triangulation and 8-inch detail survey of teak reserves in the Thána district.

(2) *Central Circle.*—Supplementary triangulation and detail survey on the 8-inch and 4-inch scales in Násik district.

(3) *Southern Circle.*—Supplementary triangulation and traversing and 4-inch detail survey in Belgaum, North Kánara and Dhárwár districts.

A small area was also surveyed on the 8-inch scale in Kolába district.

173. The following table shows in detail the outturn and cost-rates for the year under report and for the two previous years:—

Description of Survey.	Outturn.			Cost-rates.		
	1899-1900.	1900-1901.	1901-1902.	1899-1900.	1900-1901.	1901-1902.
Triangulation (stations) . .	256	365	320	23·2	12·5	20·0
Traversing (linear miles) . .	191	315	504	8·2	7·1	8·7
Topography, 4-inch (square miles)	379	409·7	607	64·1	65·4	63·8
Ditto 8 „ (ditto)	236	254·8	161·5	139·5	106·7	136·1
Ditto 16 „ (ditto)	55	10·8	*Nil.*	134·1	113·0	*Nil.*

Owing to one of the triangulators having had to be sent on sick leave, the area triangulated was not so large as was hoped for. Owing to the dense undergrowth in the forests surveyed in the Southern Circle, it was found necessary to do more traversing than has been done for some years.

The outturn of 4-inch detail survey is much in excess of that of the two previous years, while that of 8-inch detail survey shows a decrease. Taking into consideration the relative values of the different scales the total outturn of the party is nearly the same as for last year. The slight decrease in outturn as compared with the average of the last three years is due to the very heavy losses the party has sustained recently from plague and fever. The young apprentices who have been trained to take the places of the experienced surveyors who have died, have not yet had time to attain the proficiency necessary to give a full outturn of first-class work.

The cost-rates for the year under report, except in the case of 8-inch detail survey, are very much the same as those of the two preceding years. The cost-rate of 8-inch detail survey has increased from R106 to R136 per square mile. The favourable rate for 1900-01 was due to Mr. Norman having held charge of the party in addition to his other duties for the whole year. In 1901-02 there was a large increase in the charge for supervision, while, owing to the causes mentioned above, the outturn was somewhat less. The cost-rates considered apart from the charge for supervision, which varies from year to year, may be considered satisfactory. The total cost for the year was R71,364, as compared with R62,350 in 1900-01, the increase is principally due to increased charges for supervision.

174. The work was examined and tested while in progress by the officer in charge and the camp officers.

175. During the recess most of the mapping of the past season's work has been completed.

176. The programme for 1902-03 is in continuation of that for the past season.

177. The party was inspected on 8th and 9th September by Major F. B. Longe, R.E., Officiating Surveyor-General, and by Major P. J. Gordon, I.A., Superintendent, Forest Surveys, who has been placed in administrative charge of the party from 1st August 1902.

BURMA.

No. 20 Party.

178. Captain A. H. B. Hume, R.E., held charge of the party throughout the year under report.

The party left recess quarters at Dehra Dún in the middle of November, but, owing to many of the men being delayed in quarantine at Rangoon on account of an outbreak of cholera on the voyage from Calcutta, field work was not commenced until the middle of December. Field work was closed in Upper Burma on the commencement of the rains in the end of May and in Lower Burma in the beginning of June.

179. The party was divided into five camps as follows:—

(1) Mr. P. F. Prunty with 14 traversers and five computers, Upper Chindwin and Myittha divisions.
(2) One Surveyor, with 12 traversers and five computers, Minbu division, and later in Thayetmyo.
(3) Mr. G. P. Tate with 15 detail surveyors, Minbu division.
(4) Mr. M. C. Petters with 14 detail surveyors, Minbu division, and later in the Upper Chindwin.
(5) Mr. S. M. Fielding with five detail surveyors, Upper Chindwin division.

Three sub-surveyors were also detached for work in Ataran, and one for work in the Pyinmana division. Owing to advance traverses in the Upper Chindwin being insufficient it was necessary to delay sending a full detail camp there until February when more data were available. In order also to allow of the detail survey in the Minbu division being completed during the season it was necessary to send the traverse camp which afterwards worked in Thayetmyo, there for the first three months of the season. These changes during the field season resulted in loss of time and outturn but were inevitable.

180. The officer in charge of the Upper Chindwin traverse camp, in addition to its supervision, triangulated an area of 250 square miles based on the Manipur Minor Meridional series. This series, which was completed this year, has proved of the greatest service to forest survey operations in the Upper Chindwin, and had its data not been available a long and expensive triangulation would have had to be carried out by No. 20 Party before forest surveys could have been commenced in that part of the country.

181. Owing to the denseness of the forest growth the topography in this party has to be entirely based on theodolite traverses, the area topographically surveyed being divided into blocks of six to ten square miles. One thousand two hundred and seventy-one linear miles were traversed in the various divisions and 23,098 traverse stations fixed and marked with posts. Vertical as well as horizontal angles were observed, giving a large number of heights for the plane-tablers. The computation of most of the traverse work was done in the field and traverse plots were supplied to the detail camps as required.

182. An area of 724 square miles of reserved forests was surveyed on the 4-inch scale in the Upper Chindwin, Minbu, Pyinmana and Ataran Forest divisions. The country was difficult to survey, being hilly and densely wooded. Supplies were scarce and arrangements had to be made for keeping food depôts supplied in order to avoid any chance of the work being delayed.

183. The work of the season was carefully and thoroughly examined while in progress by the officer in charge and his assistants. The testing was in the proportion of one linear mile to every 2·3 square miles of detail survey. In addition to the area surveyed, a further examination and revision of work done during the previous year was carried out. A record of forest growth and soil was made of the area surveyed, and the limits of the teak-growing areas were shown on the maps.

184. Although the general health of the party was fair there were numerous casualties. One sub-surveyor and ten *khalasis* died of cholera, six *khalasis* of fever and dysentery and one sub-surveyor of heart disease. One sub-surveyor also was invalided on account of leprosy.

185. During the recess the computations of triangulation and traversing have been brought up to date. The mapping of the current season's work has been completed and 28 sheets submitted for publication. Forty-one sheets of previous season's work have also been completed, examined and submitted, as well as 12 sheets on the 2-inch scale for reduction to one-inch standard sheets.

186. The total cost for the survey year ending 30th September is R1,74,283 or R1,000 in excess of last year's total.

The increase was due to a larger number of men being employed in Upper Burma, where local and travelling allowances are higher than in Lower Burma, to increased charges for supervision and to a sum of some R14,000 having been expended on the mapping and publication of previous season's work. These extra expenses were, however, partly counterbalanced by a saving in the charges for conveying the party from the field to Rangoon, due to the courtesy of the Marine Transport Officer, who placed Government steamers at the disposal of the officer in charge for the purpose of conveying his men from the field. It is hoped that it will be possible to continue this excellent arrangement in future.

187. The following table shows the cost-rates and outturn for the year under report and for the two previous years :—

Description of work.	Area surveyed.			Cost-rate per square mile.		
	1899-1900.	1900-1901.	1901-1902.	1899-1900.	1900-1901.	1901-1902.
Triangulation .	1,170	534	250	23·4	33·5	15·0
Traversing . .	1,029	1,237	1,646	65·2	56·5	53·5
Topography, 4-inch .	708	873	724	97·5	97·8	122·3
Ditto 2-inch .	*Nil.*	5	*Nil.*	*Nil.*	80·0	*Nil.*

The cost-rates of both triangulation and traversing are less than those of former years. The cost-rate of detail survey, on the other hand, is R25 per

INDIA
SHOWING PROGRESS OF
FOREST SURVEYS
Up to 30th September 1902
TIBET
CHINA
NEPAL
BHUTAN
ASHMIR
RAJPUTANA AGENCY
CENTRAL INDIA AGENCY
HYDERABAD
BASTAR
MYSORE
ARABIAN SEA
BAY OF BENGAL
LACCADIVE ISLANDS
MALDIVE ISLANDS
CEYLON
ANDAMAN ISLANDS
NICOBAR ISLANDS
MALACCA STRAITS
GULF OF SIAM
SHAN STATES
LUSHAI
Bengal Presidency
Bombay
Madras
REFERENCES
Surveyed during 1901-02
Surveyed previously
Compiled under the supervision of Major F. J. Gidden, I.S.C., Superintendent, Forest Surveys, Bengal Presidency.
Published under the direction of Colonel St. G. C. Gore, R.E., Surveyor General of India. December 1902.
Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dun.
NO. 762-S. 02.

square mile more than for 1899-1900 and 1900-01. The increase is capable of a satisfactory explanation and is due to a decrease in the outturn owing to the detention of the party in quarantine, to the transfer of a detail camp from Magwe to the Upper Chindwin during the field season, and to the employment of three surveyors on revision survey. But for this the outturn might reasonably have been expected to equal, if not exceed, that of last year—in which case the cost-rate would have been more favourable. It must not be lost sight of that both in 1899-1900 and 1900-01 a considerable portion of the area surveyed was situated on the coast where the work was comparatively easy and the outturn per man double what is possible in the hills.

The delays affected the cost of the traversing equally with that of the detail survey.

188. The programme for 1902-03 includes—

(1) Traversing and triangulation in the Myittha, Lower Chindwin and Yaw divisions, and 4-inch detail survey in the Upper Chindwin and Myittha.

(2) Traversing and 4-inch detail survey in Thayetmyo division.

(3) Traversing and 4-inch detail survey of recent extensions in Thaungyin division, maps of which are urgently required for working plans.

189. The party was inspected in the field by the Superintendent, Forest Surveys, during February and in recess by the Officiating Surveyor-General in July, and again by the Superintendent, Forest Surveys, in August.

OPERATIONS OF THE FOREST SURVEY BRANCH.

190. Major P. J. Gordon, I.A., held administrative charge during the year of the Forest Surveys, Bengal Presidency, which, under the orders of the Inspector-General of Forests and the professional control of the Surveyor-General, continued the survey of forest reserves in the several provinces of the Bengal Presidency.

191. The operations of the various detachments are briefly reported on in the following paragraphs, and the full details will be published, as usual, in the Annual Progress Report of Forest Surveys, Bengal Presidency.

192. *Central Provinces.*—Four detachments constituted as follows carried on the survey of the forests in the Central Provinces :—

Mr. J. Marten with 15 surveyors in Mandla.
A native surveyor, with 12 surveyors in Mandla.
Mr. J. H. Nichol with 15 surveyors in Chánda.
A native surveyor, with 12 surveyors in Chánda.

193. The outturn and cost-rates for the year under report, and the two previous years, are given in the following table :—

Description of work.	Outturn.			Cost-rates.		
	1899-1900.	1900-1901.	1901-1902.	1899-1900.	1900-1901.	1901-1902.
				₹	₹	₹
Triangulation .	497 S. M.	697 S. M.	1,350 S. M.	5·1	2·3	2·0
Traversing .	184 L. M.	181 L. M.	363 L. M.	18·4	8·3	7·0
Levelling . .	791 L. M.	829 L. M.	1,057 L. M.	2·9	1·4	1·7
4-inch detail survey . .	1,423 S. M.	1,556 S. M.	1,424 S. M.	39·0	36·8	29·4
16-inch boundary survey . .	2,597 L. M.	1,691 L. M.	1,893 L. M.	...	2·1	2·2

The results both as regards outturn and cost-rates may be considered satisfactory.

194. With the exception of about 200 square miles in Chánda, which will be surveyed in 1902-03, the survey of the forest in Central Provinces is now complete.

195. The mapping and publication of the Central Province sheets has made considerable progress. One hundred and seventy-four sheets were sent to press during the year, and 178 have been published. There still remain 230 sheets in press and in different states of progress.

196. *Bengal.*—A detachment of 20 surveyors under Mr. A. Ewing continued the survey of the reserved and protected forests in Singhbhum, 6 surveyors surveyed the Kodarma reserve and protected forests in Hazáribágh, chiefly for the purpose of locating the mica mines there.

197. The survey of the remaining protected forests in Singhbhum will be postponed until 1903-04 pending final settlement. The programme in Bengal for 1902-03 consists of a 4-inch detail survey of the forest reserves in Kurseong and Darjeeling.

198. The outturn and cost-rates for the year under report and for the two previous years, are given in the following statement :—

Description of work.	Outturn.			Cost-rates.		
	1899-1900.	1900-1901.	1901-1902.	1899-1900.	1900-1901.	1901-1902.
				₹	₹	₹
Triangulation .	150 S. M.	650 S. M.	382 S. M.	21 per S. M.	2 per S. M.	2 per S. M.
Traversing . .	...	167 L. M.	78 L. M.	...	24 „ L. M.	17 „ L. M.
4-inch detail survey .	185 S. M.	361 S. M.	427 S. M.	81 per S. M.	61 „ S. M.	48 „ S. M.*

* Including Kodarma survey.

The conditions of the survey for the three seasons are practically the same, and the favourable results for the year under report are greatly due to the zeal and energy of the camp officer who has held charge of the Singhbhum detachment for two years.

199. The mapping of the Singhbhum survey is complete, but most of the sheets have been withheld for the verification of the boundaries of the protected forests. Tracings of the work have, however, been supplied to the Forest Department, so as to avoid delay in the preparation of the working plans.

200. *Burma.*—Past experience having shown the impossibility of the officer in charge of No. 20 Party exercising effective control over detachments working in all parts of Burma, it was decided as far as possible to limit the operations of that party to the Chindwin Valley and the lower Irrawaddy, leaving the remainder of the Burma forests to be surveyed by detachments of the Forest Surveys working directly under the supervision of the Superintendent in the same manner as the detachments in the Central Provinces and Bengal. Advantage was taken of an area in the Ruby Mines district which had been traversed in advance by No. 20 Party in the previous year, and a detachment consisting of 16 surveyors under Mr. C. Litchfield was detailed for the work.

201. The outturn and cost-rates were as follows :—

Description of Survey.	1900-1901. 20 Party.		1901-1902. Forest Survey Detachment.	
	Outturn.	Cost-rates.	Outturn.	Cost-rates.
		₹		₹
Traversing	427 L. M.	34	190 L. M.	29 per L. M.
4-inch detail survey . .	318 S. M.	79	274 S. M.	86 „ S. M.

For the sake of comparison the results of a detachment of No. 20 Party working in the same district under somewhat similar conditions are also given.

The fact of No. 20 Party having had to place a considerable area traversed by it during the previous year at the disposal of this detachment indirectly affected disadvantageously the results of No. 20 Party for the year. This detachment, like No. 20 Party, suffered a considerable delay through some of its members having been detained in quarantine in Rangoon.

202. The mapping of the Ruby Mines survey is well advanced and a sufficient number of maps have been supplied to enable a Working Plans party to commence operations next year.

203. During the coming season, in addition to the detachment which will continue the 4-inch detail survey in the Ruby Mines and Bhamo, a traverse detachment will be also sent to do advance traversing in the Ruby Mines, Bhamo and Mandalay.

204. *Punjab.*—In the Punjab Mr. Ewing with 10 surveyors surveyed 100 square miles of the Jubbal and Tarhoch State Forests in October and November at a cost of R23 per square mile for the field survey. A triangulator was also sent to Hazára to complete the triangulation of the forests in the Siran range.

205. The mapping of the Jubbal and Tarhoch surveys is well advanced, but so far none of the sheets have been sent to press. The publication of the Chamba maps is still in a backward state owing to the sheets having been withheld for verification of boundaries. As, however, it has been found possible to accept most of the boundaries as surveyed without further verification by the Forest Department, it is hoped that the entire series will be sent to press during next year.

Owing to the greater urgency of other work very little has been done during the year on the remaining 1-inch sheets of Chamba and Bashahr.

206. The programme for 1902-03 in the Punjab and North-West Frontier Provinces consists of the completion of the Jubbal and Tarhoch survey, and of the 4-inch detail survey of the forest reserves in the Khagan and Siran ranges in Hazára, and of some selected reserves in Ráwalpindi and Gujrát.

207. *United Provinces of Agra and Oudh.*—A small detachment, under a surveyor, surveyed 324 linear miles of forest boundaries in Oudh on the 4-inch scale during the year.

208. The programme in these Provinces for 1902-03 consists of the 4-inch detail survey of some recently demarcated reserves in Bijnor, Kumaun, Garhwál and Naini Tal and Almora.

209. The first edition of the Kumaun and Garhwál forest maps having been exhausted the series will be brought up to date and a second edition published.

210. The total cost for the year was R1,58,767 (including R33,781 for head-quarters), as compared with R1,50,352 in 1900-01. The increase is principally due to the extra expenditure in connection with the Burma detachment.

211. The general results of the work done by the Forest Survey detachments both as regards cost and outturn are satisfactory.

With the approaching completion of surveys in the Central Provinces, a field favourable to large outturn and cheap cost-rates, and useful for training young apprentices, will be lost to the Department. The work before the Forest Branch in the future will consist for the most part of surveys in Bengal, Assam and Burma where the character of the country and the cost of labour and transport will render operations tedious, difficult and costly. Hitherto the Forest Survey Branch has been able to utilize to a great extent traverse and triangulation already done by Survey of India parties. In the future, especially in Assam and Burma, much of the triangulation and all the traversing will have to be done by the Forest Survey Branch itself.

212. The publication of maps has made good progress during the year, 298 maps having been published as compared with 151 in 1900-01.

CADASTRAL AND TRAVERSE SURVEYS.

UNITED PROVINCES OF AGRA AND OUDH.

NOS. 2 AND 8 PARTIES.

213. The Provincial Surveys in the United Provinces of Agra and Oudh remained during the year under the charge of Captain W. M. Coldstream, R.E., as Superintendent. The work has been carried out by three sections, namely, the traverse, drawing and cadastral sections, the last consisting of four district cadastral detachments. There has also been a small detachment working on town and cantonment surveys in Fyzabad and Ajodhya, under the direct supervision of the Superintendent.

214. *Traverse Section.*—As the programme of traverse work for cadastral purposes had been practically exhausted in the previous season, the greater part of the traverse section attached to the Provincial Surveys reverted to Imperial employment in October 1901. A small detachment under Mr. F. S.. Bell was retained to complete the traverse of alluvial tracts in Etah, and on the completion of this work, has been retained for a future period to undertake the surveys of roads and towns, and such traverse work as may still be required for cadastral purposes.

As it was necessary to complete both traverse and cadastral operations in Etah within the year, the sheets were plotted and all computations worked out in the field, and the skeleton plots and areas of villages made over to the district survey officer during the months of January, February, and March.

The area traversed in Etah was 181 square miles, and being in great part subject to inundation, comparatively few of the traverse stations were marked permanently, except on the main circuits, which were run along the adjoining high ground, on which every alternate pair of stations were marked by stones.

The Great Trigonometrical stations of Sarsotha and Jamalpur were connected with the work, and the error thus found was 1·12 feet per linear mile. The mean corrections obtained by observations for azimuth proved to be 4″ per angle on main circuits, 3″ on sub-circuits and 12″ on village circuits. The chaining was good throughout, the corrections made on the meridian being 3 links and on the perpendicular 0·3 links.

The cost-rate obtained by division of the total area traversed by the total expenditure on the work is ₹21-6-7 per square mile. If, however, the pay of the whole traverse section for September 1901 before the commencement of the work, which was paid in October and not included in the cost-rates of the previous season is included, the cost-rate works out to ₹30-8-4.

215. *Drawing Section.*—The drawing office was located at Naini Tal under the charge of Mr. Kennedy. Eleven standard sheets, comprising areas in Meerut and Shâhjahânpur, were submitted for publication, but have been returned for certain alterations, and for the entry of available material in surrounding districts. Work has also been in progress in 26 standard sheets in districts Bareilly, Pilibhît, Kheri and Bahraich.

Under the instructions of the Deputy Surveyor-General the efforts of the drawing office will in future be more concentrated on a limited number of standard sheets, to ensure their completion and early publication, and the staff of draftsmen reduced, in order to keep the work well within control.

216. *Cadastral Section.*—One cadastral detachment has been employed in each of the following districts: Azamgarh, Mainpuri and Etah, under Messrs. Freeman, Berkeley and Powell, respectively. In Jâlaun, in order to shorten the programme of operations by a year, two detachments were employed under Messrs. O. D. and P. C. H. Smart up to the 1st of July 1902, when one of them was disbanded, and the officer in charge, Mr. O. D. Smart, reverted from Provincial employment. The Etah detachment, which will complete the survey and record-writing of the district early in November 1902, will be disbanded. In the Jalesar *tahsil* of Etah, which was professionally surveyed in 1874, new traverse work was not required, and in place of a resurvey, the correction of the existing maps, amounting practically to a resurvey, was carried out.

UNITED PROVINCES OF AGRA & OUDH.

1901-02.

INDEX TO THE CADASTRAL SURVEY IN THE U. P. A. & OUDH.

The results of the correction were satisfactory, and experience has been gained which will, it is believed, prove valuable in the event of map correction being required in other districts where the original maps were based on professional theodolite traverse.

All maps before being passed by the officers in charge were checked by European officers, or by partallers working directly under the survey officers. The average linear amount of check lines per square mile of area surveyed was 4·6. Twenty-eight per cent. of the *khasra* or field book entries were also checked in the field. Each party was inspected during the cold weather and again in the rainy season by the Superintendent, who also checked a considerable number of maps and records in the field in districts Mainpuri and Etah.

The total area cadastrally surveyed during the year including map correction in Jalesar was 2,507 square miles, and the total expenditure in the several districts amounts to ₹1,78,562 the cost-rate being ₹71-2 per square mile. If, in addition to this expenditure in the districts, the whole cost of the Superintendent's pay and office and the cost of completion of records in Farrukhabad and Gonda is included in the cost-rates of the cadastral section, the mean cost-rate works out to ₹88-5. As the areas left for survey in Azamgarh, Mainpuri, and Jálaun are comparatively small, a higher cost-rate must be expected next year.

The number of *patwaris* in the tracts under survey was 1,187, of whom 1,019 qualified as surveyors, 94 were allowed to depute their heirs to do the work, and substitutes were provided for 69, who failed to qualify or were incapacitated through age or other causes. In addition, it was found necessary to employ 44 *amins* in the alluvial tracts of Etah and in the broken ground in the other districts, but in all cases the record-writing was done by the *patwaris* or their heirs. The average outturn in survey per man per diem was 11 acres and in record-writing in the field, 27 numbers, and on map correction, 27 acres.

217. *Town Surveys.*—The following town surveys have also been completed:—

(1) A survey on the 64-inch scale of Cawnpore Municipality comprised in 193 sheets at the cost of ₹4,635, the cost-rate being ₹553 per square mile.

(2) A survey on the 64-inch scale (with open ground on the 16-inch scale) accompanied by the preparation of a record-of-rights of Ajodhya and Fyzabad for the Local Government comprised in 57 sheets.

The cost-rate of the work up to date, which does not include the completion of the records still remaining to be done, is ₹1,013 per square mile.

(3) A survey on the 12-inch scale, with bazars on the 64-inch scale, of Fyzabad Cantonment for the Military Department, comprised in 7 field sheets, the cost-rate being ₹68-6 per square mile.

(4) The survey of an extension of the civil station of Allahabad, on the scale of 200 feet to the inch comprised in 9 field sheets. The cost-rate of this survey cannot be given till the close of the financial year, when the share of the cost of the traverse section, by which it was executed, will be known.

Each sheet of the above town surveys has been passed after check on the ground either by the Superintendent or by partallers. The execution of such surveys in future will be much simplified as they will form part of the regular programme of the traverse section, a share of the cost of which will be debited to each survey undertaken.

218. During the field season, in addition to the inspection of the traverse and cadastral sections and each town survey, the Superintendent personally conducted a survey training class of 9 Assistant Collectors at Kásganj in the Etah district, and also, under instructions from the Board of Revenue, inspected and reported on the village maps of the Bánda district.

219. *Road Surveys.*—These were continued in Farrukhabad, Mainpuri, and Jálaun under the system of previous seasons, and 599·51 linear miles of roads were traversed, and the boundaries and other detail recorded in field books for the Public Works Department. The cost-rate worked out to ₹6-10-3 per linear mile. A new method by which plane-table charts will be prepared without field books has been approved by the Public Works Department.

In the rainy season the Superintendent inspected each cadastral party, and checked the work in the town and cantonment surveys of Allahabad, Fyzabad and Ajodhya.

220. The programme of surveys for 1902-03 is as follows :—

(1) *Traverse.*—Three hundred square miles in district Moradabad.

(2) *Cadastral.*—The completion of the cadastral survey, and record-of-rights under the two years' system in the following districts :—

Azamgarh	*tahsil*	Muhammadabad.
Mainpuri	„	Mustafabad and Shikohabad.
Jálaun	„	Jálaun and Kúnch.

(3) *The training of patwaris*, to enable them to maintain their maps in those parts of Allahabad where the cultivation is fluctuating.

(4) *Municipalities.*—The survey on the 64-inch scale (with open ground on the 16-inch scale) of Koil (Aligarh), Háthras, Sikandra Ráo, Atrauli, entirely at the cost of the Municipalities concerned.

(5) *Roads.*—The survey of Public Works Department roads in Etah, Agra, Muttra, Aligarh, Bulandshahr, Moradabad, Meerut, Muzaffarnagar and Saháranpur, at the cost of the Public Works Department.

221. The offices of the traverse and drawing sections at Naini Tal were inspected by the Surveyor-General and Deputy Surveyor-General in October 1901, and the Deputy Surveyor-General inspected the drawing office again in October 1902.

BENGAL.

No. 4 Party.

222. The traverse and cadastral survey operations in Bengal employed 5 traverse and 4 cadastral camps and detachments. The outturn of work accomplished, *viz.*, 4,171 square miles traverse, 2,132 square miles cadastral, 2078 square miles record-writing and 23 square miles of topographical survey, is fully up to the programme, and is comprised in major operations in 10 districts and 9 minor surveys. The outturn was considerably larger than that of the foregoing year, and great difficulty was experienced in obtaining the necessary extra establishments. A training school was formed at Dumka for theodolite traverse surveyors, and tindals and local *amins* were trained at Kálimpong and Barisál for the Darjeeling and Backergunge surveys respectively.

Darjeeling.

223. The survey of the Kálimpong Government estate, area 182 square miles, proved a very difficult task, especially with the indifferent local establishments available. The work commenced in October 1901 and was completed by July 1902. The expenditure on traversing was ₹11,146, with a resultant cost-rate of ₹61·2 per square mile. This high cost-rate is due to the very hilly and difficult nature of the country, which made chaining impossible and compelled the utilization of the subtense bar method of arriving at distances throughout the area under survey. The cadastral survey and record-writing, cost ₹29,811 which gives a cost-rate of ₹163·8 per square mile. This includes the cost of providing chainmen and coolies at very high local rates and, considering the very difficult nature of the work, is not an excessive cost-rate.

Monghyr.

224. The area traversed, *viz.*, 196 square miles, to complete the district as far south as the southern high bank of the Ganges was all low lying and practically all *diára*. Within this tract a considerable number of villages of the Srinagar-Baneli Raj which had been surveyed in 1887-88 were excluded from the current operations. A great deal of trouble was experienced in attempting to connect the new traverses with the old, as although in many cases marks of the former survey were found on the ground it was evident these marks were not in their original positions, and it appears that the marks had been shifted from the traverse points on to the true boundaries of the villages. The result was that no

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Engraved at the Survey of India Office, Calcutta.

No. 501-S., 03.

BENGAL SURVEY.

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connections could be made and new traverses had to be run along the Srinagar-Baneli village boundaries and the two surveys fitted together by means of an overlap survey during the cadastral stage. The expenditure on traversing, including cost of putting down a line of permanent marks along the southern high bank of the Ganges for purposes of future connection, was R7,283, which gives a cost-rate of R37·1 per square mile.

The cadastral survey of 640 square miles and the record-writing of 652 was accomplished during the season under report. This area comprised the 196 square miles traversed during the same season and the balance consisted of high lands traversed during previous seasons. The expenditure, including the detail overlap survey referred to above which covered an area of 20 square miles, was R78,235 and the resultant cost-rate is R121·4 per square mile, which is a low rate for Bengal surveys when it is remembered that the services of the Land Records staff are not available free of charge as in other Provinces, and that all labour has to be paid for in full and at high rates. In addition to the cadastral survey an area of 20 square miles consisting of permanently settled estates lying in the Ganges *diára* has been surveyed topographically on the 16 inch =1 mile scale at a cost-rate of R17·3 per square mile.

PURNEA.

225. The cadastral survey with records of the Súrjapur *pargana*, which had been traversed during the previous season, was carried out during the year under report. The area accomplished of both cadastral survey and records was 728 square miles at a cost of R1,37,364 which represents a cost-rate of R188·7 per square mile. The reasons for this rate being higher than that of Monghyr are several, *viz.*, (*a*) unhealthiness of the tract under survey, (*b*) higher rates of payment for labour and (*c*) smaller average size of the field. The Kishanganj sub-division of the Purnea district is notoriously one of the most unhealthy tracts in Bengal and the establishments suffered very severely. Never more than half the establishment was fit for field work and even such men as could work were debilitated by malarial fever and gave very low outturns of work. A large number of men absconded, and out of the many men who had to be sent to their homes a considerable number have died. The European supervising establishment have suffered equally severely.

BHÁGALPUR.

226. The traverse survey of the Bhágalpur district was commenced during the year under report, and an area of 1,095 square miles has been accomplished at a cost of R28,654, which gives a cost-rate of R26·2 per square mile.

GAYA.

227. An area of 121 square miles, representing the Deo Wards estate, has been traversed for subsequent cadastral survey by the Settlement Department. The estate is comprised in two main and several small scattered blocks. The expenditure has been R4,701, which gives a cost-rate of R39 per square mile.

BACKERGUNGE.

228. The traverse operations in this district, which were in continuation of those of the previous year, covered an area of 690 square miles, but out of this area 40 square miles, having already been surveyed in detail by the Settlement Department, have now been traversed only with a view to obtaining the true geographical values of the trijunction points. The whole tract under survey is intersected by tidal rivers and narrow winding creeks, and is therefore difficult to work in. The work was much delayed at the commencement of the field season by the unusually late and heavy rains, and afterwards by stormy weather in the Bay which made work among the islands dangerous. The entire tentage of the detachment was destroyed in a cyclonic storm on the 13th of March, but fortunately the records were carefully secured, and suffered no damage. The expenditure was R42,726, which gives a cost-rate of R61·9 per square mile. The reasons for this high rate are to some extent apparent from the foregoing remarks, but it must also be remembered that all labour has to be imported, and

paid at very high rates. The cadastral survey and record-writing was confined to the area traversed during the previous season. The area accomplished was 569 square miles of cadastral survey, and 503 of record-writing. The cost-rates are R170·8 for cadastral survey and 102·5 for record-writing. These abnormally high cost-rates are due mainly to the very inferior material the establishment was composed of, and also to the heavy expenditure on coolie labour. The majority of the Bengali inspectors and *amins* have proved to be very corrupt and lazy. The average outturn per *amin* amounted to only 250 acres a month. For this outturn, the expenditure on his chainman and coolies was R32 a month, which represents, with additions for proportionate shares of supervision, an approximate cost-rate of R101 per square mile. The utilization of a purely Bengali agency had been insisted upon, but the introduction of a proportion of foreign inspectors and *amins* has now been agreed to, and this, with several other changes, affords every reason for anticipating a very large reduction in the cadastral rates. Bengalis must, however, be employed on the record-writing, which is very intricate, and on the completion of records and statistics, so no very great reduction under the head of record-writing can be anticipated. During the recess season 400 *amins* and *moharrirs* were trained for the completion of records and statistical work, but in August about half absconded owing to an outbreak of cholera and had to be replaced by untrained establishments.

SONTHAL PARGANAS.

229. During the year under report 788 square miles of private estates have been traversed for subsequent detail survey by the Settlement Department, also 243 square miles have been traversed with a view to obtaining the true geographical values of the trijunction points in a tract of country surveyed some years ago in detail by Mr. Craven. This trijunction traversing will allow of the utilization of Mr. Craven's maps, after reduction and topographical revision, for standard mapping purposes. The cost-rates are R43·8 per square mile and R6·6 per square mile for the ordinary *mouzawar* traversing and trijunction traversing respectively.

SINGHBHUM.

230. The traverse survey of the Ánandapur estate and of the remaining portions of Poráhát and Kera estates has been accomplished during the year under report. The whole area traversed was 298 square miles, which completes the programme in this district. The cost-rate of the work was R31·9 per square mile.

RÁNCHI.

231. The traverse survey of the Munda country in this district has been commenced, and 430 square miles in the south-eastern portion of the district has been traversed during the year. The tract of country under survey was very hilly and jungly, and the subtense bar had to be used generally instead of the chain. This portion of the district is very unhealthy and the establishment suffered severely from malarial fever and several men have died. The cost-rate of the work was R60·5 per square mile. The reasons for this high rate are as indicated above.

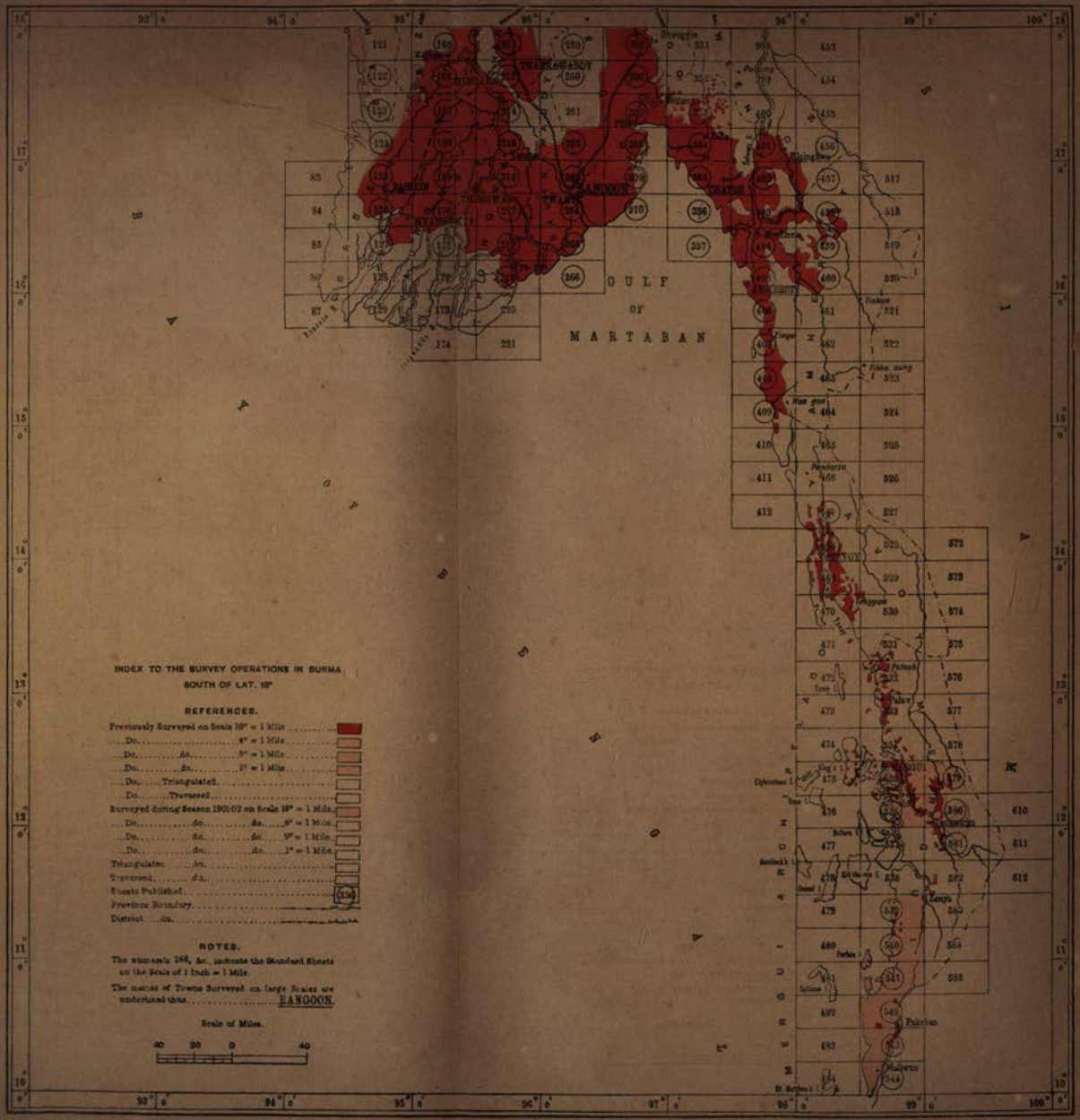
MISCELLANEOUS SURVEYS.

232. In the Patna district 47 square miles of scattered Government estates have been traversed. In Bhágalpur 3 square miles in the Ganges *diára* have been surveyed topographically. In Malda the boundaries of some Government estates have been relaid. Surveys in connection with the relaying of boundaries for the settlement of boundary disputes have been carried out in the Champáran, Shahabad, Monghyr and Darbhanga districts. A large scale survey of the Monghyr fort and surrounding area has been accomplished, and in Southern Monghyr 36 Government estates, with an area of 11 square miles, have been traversed and cadastrally surveyed. The boundary of the Baikuntpur estate in the Jalpaiguri district, which had been relaid during the previous season, has now been permanently marked.

BENGAL DRAWING OFFICE.

233. During the year under report the general extension of work on Bengal surveys and the taking over of the work of reproduction of village maps by the

BURMA SURVEY.



INDEX TO THE SURVEY OPERATIONS IN BURMA NORTH OF LAT. 16°
REFERENCES.
Previously Surveyed on Scale 16" = 1 Mile.
Do. do. 8" = 1 Mile
Do. do. 4" = 1 Mile
Do. do. 2" = 1 Mile
Do. do. 1" = 1 Mile
Do. Triangulated
Do. Traversed.
Surveyed during Season 1902-03 on Scale 16" = 1 Mile
Do. do. do. 8" = 1 Mile
Do. do. do. 4" = 1 Mile
Do. do. do. 2" = 1 Mile
Do. do. do. 1" = 1 Mile
Triangulated do.
Traversed do.
Revenue Survey Revised
Sheets Published
Province Boundary
Districts
NOTES.
The numerals 197, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.
The names of Towns surveyed on large Scales are underlined thus MANDALAY.
Scale of Miles.
40 20 0 40
BENGAL
ASSAM
SIAM
MANDALAY
MYINGYAN
MEIKTILA
YAMETHIN
MINBU
THAYETMYO
PAKOKKU
MAGWE
YENANGYAUNG
KYAUKPYU
AKYAB
SANDOWAY
KINDAT
MONYWA
SHWEBO
KATHA
BHAMO
MOGOK
LASHIO
KYAUKSE
MYITKYINA
WUNTHO
HOPIN
KUNLONG
KENGTUNG
MONG HSAT
MONG PAN
LOIMWE
TAUNGGYI
YAWNGHWE
PAPUN
SALWEEN
SITTANG
PEGU
TOUNGOO
THAYETMYO
PAKOKKU
MAGWE
YENANGYAUNG
KYAUKPYU
AKYAB
SANDOWAY
KINDAT
MONYWA
SHWEBO
KATHA
BHAMO
MOGOK
LASHIO
KYAUKSE
MYITKYINA
WUNTHO
HOPIN
KUNLONG
KENGTUNG
MONG HSAT
MONG PAN
LOIMWE
TAUNGGYI
YAWNGHWE
PAPUN
SALWEEN
SITTANG
PEGU
TOUNGOO

Vandyke process has necessitated the provision of more commodious quarters for the drawing office. A new office in Calcutta has been occupied since April 1902 which affords ample accommodation. The standard mapping of Orissa, Bihár and Chittagong is in hand, that of Orissa and Chittagong being practically completed. In Bihár a preliminary edition of the Muzaffarpur district has been published, and the standard maps of Sáran and Champáran are well advanced, whilst a start has been made with Darbhanga. The *thána* maps of the foregoing districts have made fair progress, but the publication of most has been delayed owing to discrepancies in the spelling of village names. This has now been rectified, and a large number will be available shortly. The reproduction of village maps by the Vandyke process has been taken over by the Bengal drawing office after purchase of the necessary plant from England, and has made rapid progress. The existing programme, which provides for the supply of 10 copies of 19,000 sheets of Orissa, and of 2,950 sheets of Chittagong, will at the present rate of progress be completed by August 1903. There has also been a considerable amount of miscellaneous work in the Bengal drawing office in connection with the correction of maps of current surveys in accordance with changes notified by the Settlement Department, and also in connection with the correction of spelling of village names in the maps and traverse records of several seasons' work.

234. Major R. T. Crichton, Superintendent of Provincial Surveys, inspected each camp and detachment on an average three times during the field season, and once again during his monsoon tour of inspection.

UPPER AND LOWER BURMA.

No. 7 Party.

235. The operations in Upper Burma were in continuation of those of the previous season. Mr. J. Connor continued in charge until the 6th November, when he was relieved by Major G. B. Hodgson. On the 1st September Major Hodgson proceeded on short leave and the charge devolved on Lieutenant C. P. Gunter, R.E., who joined the party on the 7th November 1901.

236. The outturn of work for the season is as follows:—

Locale.	Traversing.	Detail Survey.
Upper Burma.	Square miles.	Square miles.
Lower Chindwin (completing the district)	...	545
Pakôkku	911	...
Lower Burma.		
Sandoway (completing the district)	16	120
Kyaukpyu	145	...
Total	1,072	665

The area in Kyaukpyu proved to be nearly double the estimate, and only about half of it was traversed. This under-estimation appears to be due to the fact that the local authorities, in stating their requirements, only gave the estimated area of the land under cultivation, whereas the *kwin* boundaries had to be traversed and they enclose a much larger area than the cleared lands.

237. The following alterations in procedure, etc., were made this season:—

(*a*) Topographical details in jungle were omitted, and the rigorous survey of village sites discontinued.

(*b*) New arrangements were introduced for supplying printed copies of the 16-inch cadastral sheets to the local authorities.

The traces which they have hitherto always received at the end of each season are now sent to Calcutta in batches of 100 or so at a time, and 30 printed copies of each trace struck off at once by the Vandyke process and

despatched to Deputy Commissioners, so that about three months or so after the close of each season, the full number of copies of each map required by the Settlement Department should be in their hands.

(*c*) When no longer required by the survey party, the original field sheets will in future be sent to the Deputy Commissioners of districts for record, instead of to the Surveyor-General's Office at Calcutta.

(*d*) The preparation of duplicate area statements was discontinued.

238. During the field season the sections employed in Upper Burma enjoyed excellent health, but during recess at Mandalay there was a good deal of sickness and two computers died. In Lower Burma, as might be expected, the establishment suffered a good deal from fever and sores on the legs caused by continual wading in the brackish mud of mangrove swamps. Three men died and ten were invalided to their homes.

239. The cost-rates for the season are—

UPPER BURMA.

	R
Traverse survey, per square mile	.57
Cadastral survey, per square mile	115

LOWER BURMA.

	R
Traverse survey, per square mile	172
Cadastral survey, per square mile	209

Taking Upper Burma first, the cost of the traverse survey is a little less than it was last season. This is due to the easier nature of the work and to the larger outturn and in a small measure to the introduction during the latter part of the field season of line-clearing squads. The cost of the cadastral survey is slightly above last year's, due entirely to the higher cost of superintendence, but for which the rate would have been much less, owing to the omission of topographical details in jungle. In Lower Burma the cost of the traverse survey is less than half what it was last season owing to the larger scope of the operations.

UPPER BURMA.

240. The traverse survey was in charge of Mr. G. W. Jarbo. Lieutenant C. P. Gunter, R.E., was attached to this camp for a short time for training in practical traverse work, whilst Babu Abinash Chander Bose was employed in inspecting the traverse surveyors and line-clearers in the field. The subordinate establishment consisted of 12 traverse surveyors and 8 computers. Two probationary Superintendents of the Land Records Department, Messrs. Nolan and Adamson, were attached to this camp for one month only to learn the rudiments of traverse work. The traverse survey of the Pakôkku district was commenced this season. The area traversed comprises the Pakôkku and Yezagyo townships lying on the right bank of the Chindwin and Irrawaddy rivers. About one-third of the area consists of flat alluvial land and the rest of low hills or broken ground covered with scanty scrub jungle and deeply indented with ravines, with patches of cultivation scattered about in the valleys. Water was very scarce after the middle of February, and the surveyors sometimes had to send long distances for it. The traverse survey was not intelligently supervised. Main circuits were carried over hills and no use was made of subtense bars as should have been done. Very short lines are the rule rather than the exception, and the traverse surveyors were permitted to do their own line-clearing. This will be rectified next season. The demarcation was very defective. Wooden posts had merely been erected here and there at intervals to mark out the general run of the boundaries, but the actual boundaries were not indicated at all. This has been brought to the notice of the local authorities, and it is hoped that next season there will be an improvement. The demarcation maps were excellent and of much assistance.

The traverse section took the field on the 6th November and returned to recess quarters at Mandalay on the 24th April. The theodolite

stations were marked with galvanized iron cylinders. The angular work was checked by observations for azimuth at 90 stations and the angular error is one minute in 17 angles on main circuits, and 1 minute in 13 angles on village circuits. Double chaining was employed on main and sub circuits only and the chain measurements were checked by connection with one intersected point of the Great Trigonometrical Survey-Shinmataung h.m.—and five triangulation stations of the Topographical Survey. Unfortunately these points were all fixed during the season under review and final values were not available in time to enable the results of the connections to be computed. Without them the average error in the chaining is 0·43 links per *mille* and the circuits all closed satisfactorily. All the computations have been completed as far as possible, under the circumstances explained above.

241. Mr. J. Connor was in charge of the cadastral section until he retired, when Mr. J. S. Swiney took his place. He had only one assistant for testing the work, Babu Abinash Chander Bose, for the first half of the field season and Lieutenant C. P. Gunter, R.E., for the latter half. The survey was tested by 670 linear miles of check lines excluding those of the inspectors, an average of 6·3 linear miles to each square mile actually surveyed; but this includes boundary *partals*. Field work continued till the end of April. The average number of *amins* was 48, employed for an average of five months.

242. During recess the 16-inch field sheets were all completed and traces forwarded to Calcutta for reproduction by the Vandyke process with the exception of 99 which contain only jungle blocks and will be completed during the ensuing field season. The maps were entirely outlined in ink by the field surveyors, the boundaries only being left in pencil for comparison in office. Standard sheets 146, 149, 194 and 195 were sent to Calcutta for publication on the 1-inch scale, and sheets 102, 103, 104, 105, 147 and 148 will be sent very shortly. After publication, blue prints of these on the reduced scale will be supplied to No. 10 Party for revision of the topographical details and filling up of gaps. As there is not sufficient detail in sheets 101 and 67 to justify their publication they will be handed over to No. 10 Party, and traces, which are in hand, prepared for the local authorities. In addition to the work of the current season, traces were prepared of 599 16-inch field sheets containing 257 *kwins* of the previous season's work and forwarded to Calcutta for reproduction. There are 625 sheets of the previous season still remaining to be traced, and these will be done during next field season. Much miscellaneous work was also done for the Settlement Department and all arrears have now been completed.

The alterations in *kwin* boundaries give an immense amount of work. Fresh traces and area statements have to be prepared and the original 16-inch maps and 2-inch standard maps altered to correspond. This would be avoided if the work of the demarcation officer were examined before the survey is done. In future it will entail the printing of fresh copies of the 16-inch maps as well. Up to date the number of *kwins* so dealt with in the Yamèthin district, which was surveyed in 1896 and where settlement operations have been in progress for some time, is 642.

243. The programme for next season consists of the traverse survey of 425 square miles and the cadastral survey of 600 square miles in Pakókku and the traverse survey of 200 square miles in Shwebo.

LOWER BURMA.

244. The work in Lower Burma, both traverse and cadastral, was continued under the supervision of Mr. J. S. Swiney, under whom the previous season's work was carried out. He was assisted during the field season by Babu Jagdamba Prasad. The subordinate establishment consisted of 8 theodolite surveyors and 3 computers for the traverse survey, and 1 inspector, 13 *amins*, 2 estimators, and 5 draftsmen for the detail survey. The traverse survey of the Sandoway district was completed this season and that of Kyaukpyu taken up. The origin of survey for the two districts is the same, *viz.*, the intersection of $\frac{\text{Lat. } 18^\circ\ 00'\text{ N.}}{\text{Long. } 94^\circ\ 30'\text{ E.}}$ and is the same as that of the survey by local agency. Only the stations on the *kwin* boundaries were permanently marked with galvanized iron cylinders. The 99 *kwins* surveyed in detail were scattered in small isolated

patches dotted about throughout the district, of which the greater part has been surveyed by local agency.

The detail survey was checked by 122 linear miles of test lines excluding those of the inspector, which is an average of a little over 1 mile for every square mile of survey. The traversing was connected with two stations of the Great Trigonometrical Survey, but there is a chain error in one of the village circuits affecting the connection, which will be revised next season. The average error in the chaining on the village circuits is 0·73 links per *mille*. Double chaining was employed throughout. The angular work was checked by observations for azimuth at 49 stations, and the average angular correction is one minute in 30 angles. The demarcation was very defective and the village headmen were only able to point out the boundaries of circles (*taiks*), and as their circles were sometimes very large, the *thugyis* could not readily be got hold of. Consequently the traverse surveyors, when in difficulty, generally accepted the demarcation maps as their guide. The boundaries generally ran along a footpath, stream or other natural feature, so the maps proved of considerable use, as the nature of each boundary was carefully recorded on them. In the detail survey, the same difficulty was met with respect to the boundaries, and in jungle where no marks were found and the boundaries could not be pointed out, the traverse lines have been taken as the boundary.

245. The field establishment assembled at Sandoway on the 25th October, but field work was not in full swing till over a fortnight later. The traverse establishment had to make a journey of 130 miles by steam launch to the nearest point of the Kyaukpyu district and the *amins* proceeded by land, some of them having 120 miles to go and all having to carry their belongings themselves as carts are almost unknown in Arakan, and coolies not procurable. Field work closed on the 23rd May. The entire area that came under survey was densely wooded except where cleared for cultivation. It was intersected by numerous creeks, forming in the Kyaukpyu district a net-work of islands which are fringed with mangrove swamps extending in places to a width of nearly a quarter of a mile from the open water. Unfortunately these creeks represent the larger part of the *kwin* boundaries, and the traverse lines had to be run through the mangrove rendering the work extremely difficult and costly. The traverse computations have all been completed with the exception of the work dependent on the connection with the Great Trigonometrical Survey, of which some of the measurements require revision.

246. The 16-inch cadastral sheets were all completed and traces of all prepared and forwarded to Calcutta for reproduction. No standard fair mapping has been drawn for publication as the amount of detail falling into each sheet is so small, but as, the Land Records Department have published maps on that scale of the surveys done by local agency, 2-inch reductions have been furnished to the local office for incorporation in their maps.

247. The programme for next season is the completion of the traverse and cadastral survey of the Kyaukpyu district. The area remaining for traverse survey is supposed to be about 120 square miles and 265 for cadastral survey but these figures will probably be found above the mark, as the work will be very much simplified next season when confined to the cleared lands. With the concurrence of the Local Government the traverse lines will be run round the clearings only, and the *kwin* boundaries and topographical details in jungle will not be surveyed.

CENTRAL PROVINCES.

CENTRAL PROVINCES DETACHMENT.

248. Mr. R. C. Ewing held charge of the detachment and was assisted in the topographical revision by Mr. M. Gastaud and Khan Sahib Ikbaluddin. Khan Bahadur Imam Sharif continued in the detachment till 31st December 1901, when he proceeded on combined leave; Khan Bahadur Yusuf Sharif was in the drawing section till 18th December, when he retired on superannuation pension.

CENTRAL PROVINCES SURVEY.

INDEX TO SURVEYS IN THE CENTRAL PROVINCES.

1901-02. C. P. DETACHMENT.

Engraved under the superintendence of J. Fulton.

Reg. No. 477, S. I.—Jan. 03—600.

Additions to 1901.

Litho., R. I. D., Calcutta.

Nº 554-S. 19

249. The field operations of the season commenced on 1st November 1901 and comprised—

(*a*) Traversing of detached villages (excised from Government forest reserves) in 9 districts of the Province in compliance with the requirements of the Commissioner of Settlement and Agriculture.

(*b*) Preparation of field sections for the topographical surveyors.

(*c*) Revision in the field of the details reduced from the 16-inch scale cadastral maps surveyed by local agency, and surveying the topographical features omitted.

250. The traversing consisted of enclosing polygons in skeleton (*i.e.* without measuring offsets to boundaries) of excised portions of forest reserves, or of jungle villages whose rent being below R15 were omitted at the previous survey, but had now exceeded that sum. There was no demarcation done, nor any needed as the abandoned forest boundary formed in itself three sides of the new village, while the present boundary showed the fourth side.

The theodolite was set up on as many prismatic compass stations of the *patwari's* survey as could be found or identified, and in this connection great inconvenience was felt at the commencement by the non-attendance of the *patwaris*, who were engaged in their fiscal work.

The area traversed was as follows:—

	Square miles.
District Damoh	37·5
„ Hoshangábád	23·6
„ Chhindwára	10·9
„ Nimár	21·1
„ Chánda	35·6
„ Raipur	358·8
„ Sambalpur	119·7
„ Mandla	54·7
„ Seoni	53·5
	715·4

There were traversed 1 sub-circuit checked by 5 azimuths, 570 village circuits, and 630 sub-traverses; the polygons were too scattered to permit of main or other sub-circuits. The average angular error was 4," and the linear error per 100 chains, was 8 links. Connections were made to six G. T. stations, only one of which was used in the sub-circuit, the others being connected with detached villages, could not be used, but will be of service when computing the co-ordinates of villages from origin of survey for plotting of village trijunctions on the 2-inch field sections. The disputed boundary between *jagirs* Pagára and Batkagarh, district Chhindwára, was also traversed at the request of the Deputy Commissioner, to whom the maps and records have been sent for adjudication.

The theodolite stations of the previous surveys on village trijunctions and marked by stones, were generally found except a few riparian ones, also some of the other stations, whilst new stones were embedded where necessary in place of missing ones. The new traverse stations have been marked by embedding undressed stones, about 2 feet underground and 1½ feet above, marked at top with a circle and dot.

The computations of the season's work have been completed and the records prepared for lodgement. The 16-inch skeleton plots with their numerical data have been supplied to Deputy Commissioners for completion of the detail survey by the *patwaris*, aggregating 570 villages in 983 sheets.

The area traversed is 715·4 square miles costing R17,503 or R24-7-8 per square mile.

251. For the topographical work of revising and completing the field sections, 9 sub-surveyors were transferred to this detachment and 9 men were taken off from the drawing and traverse sections and put through a course of training. The area revised was 1,936 square miles on the 2-inch scale falling in 5 standard sheets in district Jubbulpore, the mapping of which will be completed by close of recess. The accuracy of the work was tested by 923 interpolations, and 24 miles of chaining. The hills were delineated by contours

at vertical intervals of 50 feet apart, determined by numerous clinometric deductions. The hills being low and forest clad, necessitated chaining which under such circumstances is always slow and tedious.

The details reduced from the 16-inch cadastral sheets, and transferred in blue on the field sections were found to be sometimes misleading. Limits of cultivation, which is always a fluctuating quantity, could not always be identified on the ground; again the village sites in the cadastral maps only showed the outer limits of area allotted for building on, whereas the survey had to show only the area actually occupied as such. The hills were not surveyed by the cadastral party, but were merely shown as conventional signs, and therefore of no service; streams flowing through jungle, and ravines were mere eye sketches, or omitted altogether; on the other hand the streams through cultivation, tanks, high roads and railway lines were found in correct position, though in the case of high roads and railway lines all bridges, culverts and mile-stones had to be inserted. This was the surveyors' first attempt at this kind of revision, and as many were inexperienced some attempted to be too minute, while others were disposed to generalize too freely. Much assistance was expected from village trijunctions as initial points of departure for the surveyors, but the *patwaris* and *malguzars* could not be got to attend to point out their positions, and the platforms of a very large number were found not to have been constructed. The Deputy Commissioner has notified his intention of having them constructed shortly.

The cost of this section is R18,351, which gives the result of R9-7-8 per square mile.

252. The drawing section was engaged in the preparation of field sheets preparatory to their verification, correction and completion of topographical details by surveyors in the field. The village trijunctions are first plotted, and then the original 16-inch cadastral surveys are reduced by pantograph to the 2-inch scale and transferred to the field sheets and inked in blue. The details of the 4-inch forest surveys are also reduced and transferred in burnt sienna to the field sections, by using the village trijunctions common to both. The cost of the drawing section was R7,378.

253. The party returned to recess quarters during the first week of May, when the hot winds became very oppressive and the haze obscured the hills; the topographers had uniform good health, while the traversers suffered for a short while only from malarial fever at the commencement of the field season, more particularly in the *semindaries* of Raipur.

254. The programme of the coming season comprises—

(*a*) the traversing of 671 square miles, which will complete the traverse work of this Province, so far as is at present known;

(*b*) the topographical revision of the remainder of district Jubbulpore and eastern half of district Damoh, approximately about 3,000 square miles;

(*c*) the preparation of field sections.

255. In November 1901 the drawing office was inspected, and in January 1902 the topographical revision section by Major Longe, R.E., Officiating Deputy Surveyor-General, and during the recess in August by Major Bythell, R.E., Officiating Deputy Surveyor-General.

ASSAM.

ASSAM DETACHMENT.

256. The detachment was under the superintendence of Mr. T. Shaw, Superintendent of Provincial Surveys, up to 28th July, when he proceeded on privilege leave. Mr. C. O'Donel, Sub-Assistant Superintendent, carried on the current duties of the office for the remaining two months of the year under report.

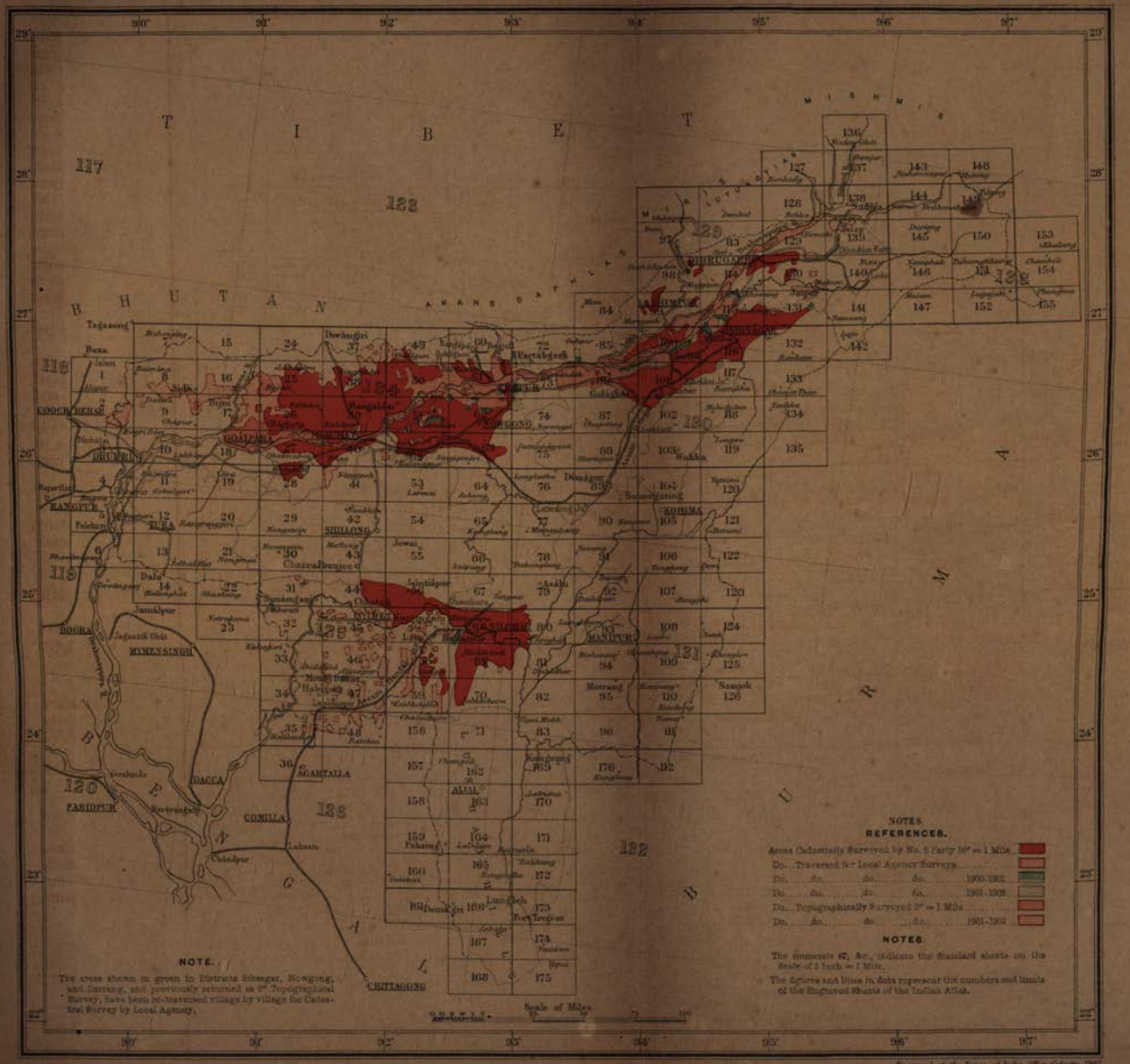
257. The season's programme consisted of the traversing of—

	Square miles.
Villages previously surveyed by local agency . . .	135·4
Villages for extension survey by local agency . . .	55·9
Tea grants	163·4

ASSAM SURVEY.

INDEX TO RECENT CADASTRAL, TRAVERSE, & TOPOGL. SURVEYS IN THE BRAHMAPUTRA & SURMA VALLEYS.

1901-02. ASSAM DETACHMENT.



A small area estimated at 15 square miles was also to be surveyed topographically on the scale of two inches to the mile, to complete standard sheet No. 41 for publication.

Besides the above there were—

	Linear miles.
Resurvey of boundary between Cherra Siemship and British villages	4½
Location of Langái Thána	8½

This programme was not completed. The actual outturn is given below:—

Traversing.

District.	Area in square miles, Tea grants.	Area in square miles, villages.	No. of azimuths observed.	Permanent marks connected.
Kámrúp	23·17	113·99	92	411
Nowgong	25·16	...	13	43
Darrang	26·69	15·40	26	167
Sibságar	18·71	...	21	65
Sylhet	...	3·15	1	92
TOTAL	93·73	132·54	153	778

Topographical survey	12·2	Square miles.
Boundary between British villages and Cherra Siemship	4·5	Linear ,,
Location of Langái Thána	8·6	,, ,,

258. The work was again scattered all over the Province in small blocks. At the commencement of the field season Mr. O'Donel's services were placed at the disposal of the district judge of Sylhet to carry out a survey and local enquiry in a civil suit between the Secretary of State and the Maharaja of Hill Tippera. Mr. O'Donel was absent on this inquiry the whole field season. In consequence of the importance attached to inspection of the land records Mr. Shaw could visit only four out of the eight surveyors at work. The small outturn must, therefore, be partially attributed to insufficient supervision of the subsurveyors in the field.

259. The cost-rates of traversing per square mile in the different districts are as shown below:—

		₹
Kámrúp	Tea grants	48
	Villages	48
Darrang	Tea grants	86
	Villages	96
Nowgong.	Tea grants	72
Sibságar.	Do.	77
Sylhet.	Disforested area	188

The very high rate for Sylhet is due to the small area completed, *viz.*, only 3·15 square miles and to the failure of the local authorities to have the boundaries cleared before the sub-surveyors' arrival on the spot. The surveyor had to be detached from the Brahmaputra valley for this work and the cost of moving him and his squad had to be debited to this small area. The area surveyed topographically on the scale of 2-inch to the mile was 12·2 square miles and it cost ₹440 or at the rate ₹36 a square mile. This survey has not yet been tested. At the end of the season a sub-surveyor was sent to district Sylhet to connect, by traverse with previous surveys, a *thána* which had been fixed by the Hill Tippera authorities on the Langái river. The Assam officials were of opinion that the *thána* had been fixed well within the district of Sylhet, but it proved to be over half a mile within Tippera territory. Much delay was caused by the nature of the country through which the traverse survey had to be carried, and by the inclemency of the weather. The total length traversed in connecting the *thána* was 8·6 linear miles and the cost ₹685.

260. The preparation of the standard sheets was continued in the drawing office. The drawing office is located at Shillong, and for seven months of the year there was no direct supervision of the draftsmen, Mr. Shaw being unable to leave his other duties in the field to even inspect the office. The progress has consequently been very slow. No sheets have yet been submitted for publication.

261. Mr. Shaw examined the maps and records of the Land Records Department in districts Lakhimpur, Sibságar, Darrang, Kámrúp, Sylhet and Cachar. A class for training local officers in practical field surveying was held at Jorhát for one month, during which time Mr. Shaw instructed one Assistant Commissioner, two Extra Assistant Commissioners and three Sub-Deputy Collectors. He also conducted examinations for first class certificates at the Survey Schools at Gauháti and Jorhát.

262. The programme for next field season consists of the following traversing :—

	Square miles.
(1) Areas which have been or are about to be surveyed by local agency	91
(2) Tea grants	221
(3) Disforested area	3

GEODETIC.

ASTRONOMICAL LATITUDES.

NOS. 22 AND 23 PARTIES.

263. There being only one Imperial officer available for Astronomical work, Nos. 22 and 23 Parties were combined during season 1901-1902 and employed on Latitude work on the Calcutta Meridional series and the Darjeeling triangulation.

264. The stations visited and the results obtained at each are tabulated below :—

Series.	Station.	Height above mean sea level.	Longitude.	Geodetic Latitude=C.	Astronomical Latitude=O.	P. E.	O—C.
		Feet.	° ′	° ′ ″	° ′ ″	″	″
Calcutta Meridional Series.	Madhupur	92	88 32	23 56 38·97	23 56 42·82	±0·040	+ 3·85
	Charaldánga	149	88 26	24 52 43·95	24 52 45·36	±0·051	+ 1·41
	Chanduria	160	88 25	25 44 27·47	25 44 31·93	±0·058	+ 4·46
	Lohágara	205	88 24	26 2 12·04	26 2 13·96	±0·055	+ 1·92
	Jalpáiguri	...	88 47	26 31 15·13	26 31 9·16	±0·056	— 5·97
	Siliguri	401	88 27	26 41 41·11	26 41 18·10	±0·080	—23·01
Darjeeling Triangulation.	Kurseong	4428	88 18	26 52 6·16	26 51 15·05	±0·060	—51·11
	Senchal	8600	88 20	26 59 8·78	26 58 32·98	±0·091	—35·80
	Tonglu	10,073	88 8	27 1 53·54	27 1 11·30	±0·096	—42·24
	Phallut	11,815	88 3	27 12 42·51	27 12 5·28	±0·073	—37·23

265. The results show that the quantity O—C maintains its positive value till quite close under the outer Himalayas, the sign changing somewhere about north latitude 26° 10′, indicating that the zone of positive deflection has, at this longitude 88°, a much greater width from North to South than had been expected. Another feature of the results is the very rapid change in the amount of O—C between Lohágara, latitude 26° 2′, where O—C = +1·92″ and Kurseong, latitude 26° 51′ where O—C = — 51″·11 giving a change of 53″ in 0°—49′ of latitude. The occurrence of the maximum deflection at Kurseong, half way up the outer ranges is remarkable. In every case, except perhaps Phallut, the Latitude station is well situated as regards local masses and at Phallut the local disturbance cannot be more than 1″·5 to the southward.

266. The result obtained at Jalpáiguri is also noteworthy. O—C here is equal to—5″·97 where close on 30″ was to be expected. At this station Longitude observations have shown the presence of an apparently abnormal deflection

in the prime vertical of 18″ East where only a small deflection was to be expected. It seems then desirable that azimuth observations should be undertaken at this station to supply evidence, corroborative or otherwise.

267. The parties were inspected by the Superintendent, Trigonometrical Surveys in June 1902.

TIDAL AND LEVELLING OPERATIONS.

No. 25 Party.

268. Captain H. L. Crosthwait, R.E., held charge of the party until the 27th January 1902, when he proceeded to attend the Chatham course, and Mr. E. J. Connor took over charge.

Tidal Operations.

269. The following stations were under observation at the commencement of the year:—

Stations. (Those shown in italics are *permanent*).	Automatic or personal observations.	Date of commencement of observations.	Date of closing of observations.	No. of years of observations.	Remarks.
1. Suez	Automatic.	1897	Still working.	5	To be closed.
2. Perim	"	1898	"	4	Ditto.
3. *Aden*	"	1879	"	22	
4. *Kurrachee*	"	1881	"	21	
5. Porbandar	"	1898	"	4	With certain interruptions.
6. Port Albert Victor (Káthiáwádar).	"	1900	"	2	
7. *Bombay* (Apollo Bandar)	"	1878	"	24	
8. Bombay (Prince's Dock)	"	1888	"	14	Property of Port Trust.
9. *Madras*	"	1880 discontinued 1895	1890 Still working.	10 / 7 = 17	
10. *Kidderpore*	"	1881	"	21	
11. Bassein (Burma)	"	1902	Newly started.	...	Started this year.
12. *Rangoon*	"	1880	Still working.	22	
13. *Port Blair*	"	1880	"	22	

270. The newly built tidal observatory at Bassein, in Burma, was started working by Captain Crosthwait on the 1st January 1902.

271. The 13 tidal observatories at work have been inspected during the year; and all the tidal registrations, except those at Porbandar, where the communication pipe again got choked with sand, have been very satisfactory.

272. The two following tables show the annual and decadal percentages of the predicted time and height errors of high and low water.

Percentages of errors in Predicted Times and Heights at Open Coast Stations from Automatic Observations.

Year.	No. of stations.	In Time. Within 15 minutes of Actuals.		In Height. Within 8 inches of Actuals.		In Height. Within 1/6 of mean range at Springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1892	8	75	74	91	85	98	98
1893	9	73	68	93	98	96	95
1894	10	65	62	95	92	97	95
1895	9	68	65	98	97	94	94
1896	9	71	70	97	97	97	93
1897	8	71	75	96	97	97	97
1898	9	74	70	96	96	95	95
1899	9	74	66	95	95	93	92
1900	11	66	60	93	88	93	89
1901	11	71	60	93	91	93	91
Average of 10 years	9	71	67	95	94	95	94

PERCENTAGES OF ERRORS IN PREDICTED TIMES AND HEIGHTS AT RIVERAIN STATIONS FROM AUTOMATIC OBSERVATIONS.

Year.	No. of stations.	In time. Within 15 minutes of Actuals.		In height. Within 8 inches of Actuals.		Within $\frac{1}{10}$ of mean range at Springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1892	2	61	60	72	65	94	95
1893	2	57	57	68	50	89	84
1894	2	56	55	66	42	88	80
1895	2	59	55	74	47	94	84
1896	2	56	55	63	42	87	74
1897	2	59	61	75	57	96	91
1898	2	53	59	71	61	90	91
1899	2	55	59	76	65	95	94
1900	2	59	62	70	57	89	87
1901	2	63	65	70	59	90	92
Average of 10 years	2	58	59	71	55	91	87

SPIRIT LEVELLING OPERATIONS.

273. The levelling detachment was again employed for a time on the Eastern Bengal State Railway, from Párbatipur to Dhubri; and for the remaining portion of the field season in Bengal, from Siliguri to Sonákhoda Base-Line; and in Assam from Fakírganj to Gauháti. It completed 259 miles of double levelling.

274. During next field season, the levelling operations will be carried on in Burma from Thazi Junction Railway Station to Magwe; and from Mandalay to Tantabin.

The detachment left Dehra Dún on the 20th October 1901, and returned to recess quarters on the 13th May 1902.

MAGNETIC.

NO. 26 PARTY.

275. Captain H. A. D. Fraser, R.E., was in charge of this party throughout the year.

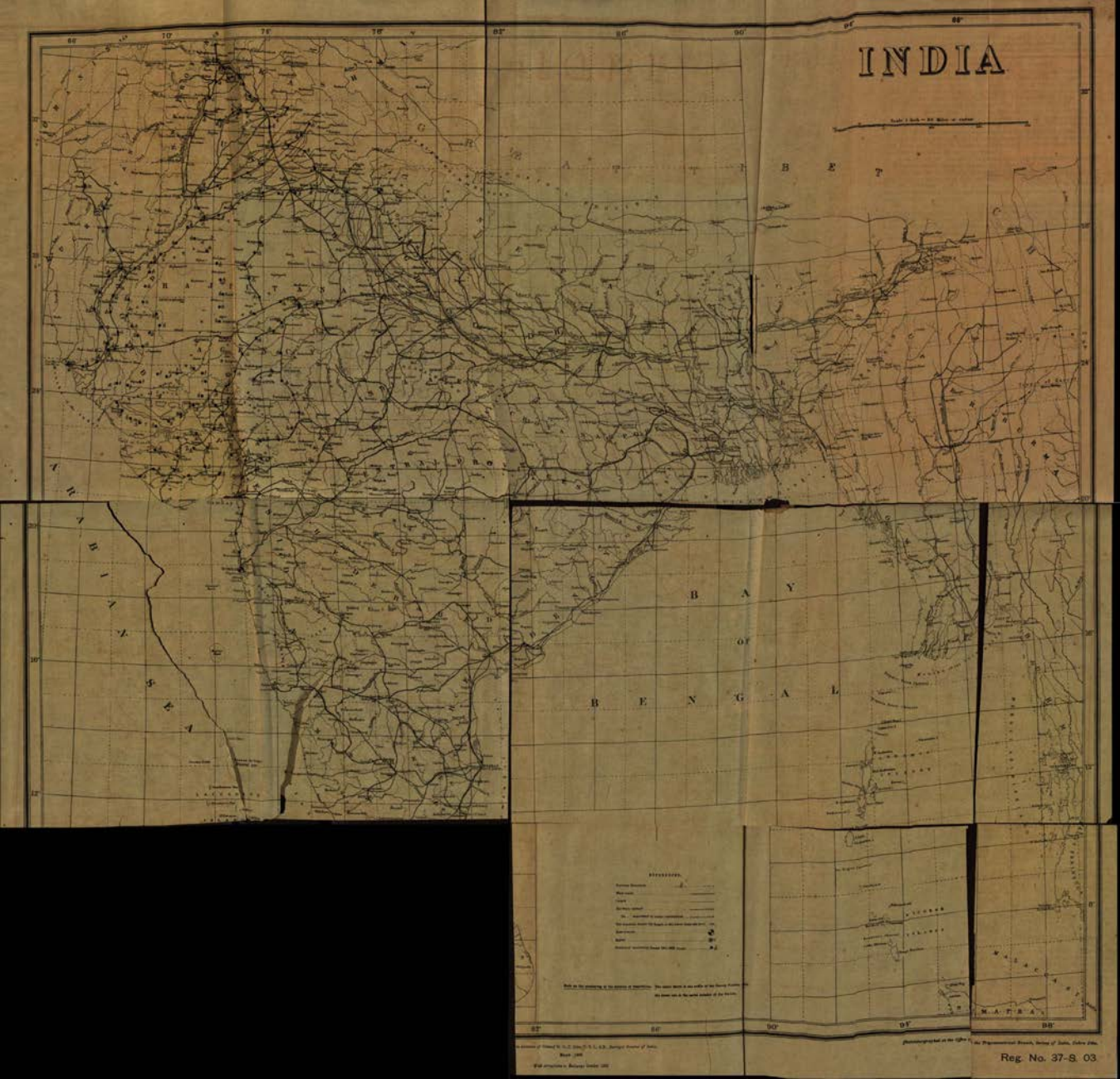
During the season under report field observations were commenced. Three detachments were employed in the area to the west of a line joining Bombay and Dehra Dún observatories and complete sets of observations were taken at each of the stations of observation the total number of which was 163.

276. Two detachments worked along lines of railways: the first along the broad gauge and the second along the narrow gauge systems lying within the area under survey. They completed 65 and 62 stations respectively. The third worked in the desert, using camel transport. This detachment observed at 36 stations averaging about 30 miles apart.

The stations of observation are clearly marked on the accompanying map of India.

277. A table is printed, in the appendix showing the values obtained, but as these are uncorrected for daily variation, secular change and instrumental differences, they are to be considered as preliminary approximate values and not as final results.

Early in March 1902, the officer in charge proceeded on tour and in addition to inspecting the work of the three field detachments, he took very complete sets of observations at five repeat stations (*vide* chart). At each of these stations three sites were occupied from one to two miles apart and the approximate results shown in the table are the means of the three groups of observations thus obtained. Each site was permanently marked and it is intended to repeat the observations at each place as often as possible in the course of the survey.



Reg. No. 37-S. 03.

278. After the return of the field detachments early in May, a long series of observations was undertaken in Dehra Dún to determine the values of the moments of inertia of the magnets of each of the instruments used in the survey. These were computed out at once and proved quite satisfactory. Subsequently the computation of the field work was taken up and completed.

279. Early in July the officer in charge proceeded to Kodaikánal and installed the self-recording instruments at that base station, returning to Mussooree about the 20th August. The whole of the necessary equipment was handed over to the Director of the Kodaikánal observatory, who is now in sole charge of the magnetic work at this station. This installation enables the area of operations for the ensuing field season to be extended to the south of India.

280. At present three out of the five base stations are in working order, *viz.*, those at Colába, Dehra Dún and Kodaikánal. Of the two remaining the buildings at Rangoon were handed over by the Public Works Department early in 1902, but the instruments originally intended for this station have not been installed as it was decided to reserve them for the Calcutta observatory as soon as it was definitely known that the existing set of instruments at Alipore would not be avilable for survey purposes.

Another set of Watson's magnetographs is now being made in England for Rangoon and is expected to arrive by the middle of 1903.

The site for the Calcutta observatory has been finally selected at Barrackpore (some 12 miles out of Calcutta itself) and work was to be begun about the 1st November 1902. It is hoped that the buildings will be sufficiently advanced by the end of February 1903 to permit of the installation of the instruments being then undertaken.

281. As the Vertical Force magnetograph at Alipore could not be utilized for survey purposes, sanction was obtained for the purchase of a new instrument of this class. When received it will be installed at Dehra Dún, as this latter is a more suitable place than Calcutta for recording the variations in the vertical force as far as the requirements of the survey are concerned.

Summary of the Outturn of Work of t

Scale of Survey.	Number of Party.	Locale of Field Operations.		Triangulation: Instrument used. Diameter in inches.	Triangulation: Area in square miles.	Triangulation: Square miles to each point trigonometrically fixed.	Triangulation: Square miles to each height.	1st Class: Stations fixed.	1st Class: Triangular error in seconds.	1st Class: Error per mile in feet.	Secondary: Stations fixed.	Secondary: Triangular error in seconds.	Secondary: Error per mile in feet.	Tertiary: Intersected points.	Tertiary: Error per mile in feet.	Spirit Levelling Operations: Miles levelled over.	Permanent bench-mark embedded.	Trigonometrical stations connected with.
Inches to a mile. 105·6	18	Simla		5, 6 & 7	3	...	...	...	...	...	14	6·8	·17	27	...	...	...	...
64	Provl. Surveys.	Cawnpore Municipality		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Fyzabad and Ajodhya Towns.		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		TOTAL		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
26·4	Provl. Surveys.	Allahabad Civil Station	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
12, 48 & 60	15	Cantonment Surveys		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
12 & 48	Provl. Surveys.	Fyzabad Cantonment		...	...	...	...	..	...	...	..	...	...	..	...	...	...	...
		TOTAL		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
16	10	Maimyo City (Revision)		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Provincial Surveys.	United Provinces of Agra and Oudh—Etah.	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		United Provinces of Agra and Oudh—Azamgarh.		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		United Provinces of Agra and Oudh—Mainpuri.		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		United Provinces of Agra and Oudh—Jalaun.		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Provincial Surveys.	Bengal, Darjeeling		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, Patna	15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, Monghyr		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, Purnea		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, Bhágalpur		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, Gaya		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, Backergunge	20	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, Sonthal Parganas		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, Singhbhum		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, Ranchi		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, Miscellaneous Minor Surveys.		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	7	Upper Burma, Pakókku	25	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, ,, Lower Chindwin.		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Lower Burma, Sandoway		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, ,, Kyaukpyu		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Central Provinces, Damoh		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Detachment.	,, ,, Mandla	30	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, ,, Seoni		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, ,, Hoshangabad.		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, ,, Nimár		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, ,, Chhindwára.		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, ,, Sambalpur.	35	...	..	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, ,, Raipur		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, ,, Chánda		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Provincial Surveys.	Assam, Kámrúp		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, Nowgong		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, Darrang	40	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, Sibságar		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, Sylhet		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, Sylhet boundary dispute.		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		TOTAL		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8	17	Bombay Forests	45	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
6	15	North-West Frontier	...	6	54	0·3	0·3	...	...	...	13	6·1	0·2	170	0·3	...	...	...
4	9 & 19	Madras Forests, Cuddapah	...	7	710	2·3	2·3	...	...	...	81	17·5	0·3	249	2·0	...	...	...
		,, ,, S. Canara	...	6	550	1·9	1·9	...	...	...	28	19	0·4	257	0·6	...	...	...
		,, ,, Kurnool	...	7	420	1·5	1·5	...	...	...	56	45	0·6	232	1·0	...	...	...
		,, ,, Gódávari	50	7	300	2·0	1·9	...	...	...	109	18	0·6	39	0·7	...	...	...
	17	Bombay Forests, Dhárwár		6 & 7	140	0·3	0·3	...	...	...	82	17	1·0	508	0·9	...	...	...
		,, ,, Belgaum																
		,, ,, Násik		6 & 7	180	0·2	0·2	...	...	...	187	00·1	0·4	940	0·6	...	...	...
		,, ,, Thána																
		Carried over	55	...	2,300	...	...	...	...	...	...	...	...	...	...	...	...	...

[F]ield Parties during the year 1901-02.

	TRAVERSING.				DETAIL SURVEY.					RECORD WRITING.			Remarks.
	Area in square miles.	Number of stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error per mile.	Area in square miles.	Plane-table fixings per square mile.	Linear miles of test lines.	Villages.	Average size of fields.	Area in square miles.	Villages.	Fields.	
...	...	2,236	2·5	1·0	...	...	...	...	...	...	...	...	
...	...	...	...	...	8·4	...	...	...	...	...	...	...	
...	...	...	...	...	4·6	...	...	...	...	...	...	...	
...	...	...	...	...	13·0	...	...	...	...	...	...	...	
5	...	...	...	...	2·1	...	...	...	...	...	...	...	
...	42	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	7·6	...	...	...	...	...	...	...	
...	42	...	...	...	7·6	...	...	...	...	...	...	...	
...	...	...	...	...	19	...	...	...	...	...	...	...	
10	181	1,038	8	1·1	668	...	...	...	...	668	...	...	
...	...	...	...	...	427	...	...	...	...	427	...	...	
...	...	...	...	...	608	...	...	...	...	608	...	...	
...	...	...	...	...	804	...	...	...	...	804	...	...	
...	182	6,719	...	...	182	...	1,182	48	3·7	182	48	31,782	
15	47	2,023	...	...	...	...	...	...	...	...	...	...	
...	196	4,077	...	...	660 (*a*)	...	3,204	332	0·9	652	336	480,619	(*a*) Includes 20 square miles surveyed topographically on 16-inch scale.
...	2	71	...	...	728	...	3,354	735	0·5	728	735	978,828	
...	1,095	19,453	...	...	3	...	...	...	...	...	...	...	
...	121	2,637	...	...	...	...	...	...	...	...	...	...	
20	690	13,678	...	...	569	...	2,514	748	0·4	503	716	720,553	
...	1,031	32,921	...	...	...	...	...	...	...	...	...	...	
...	298	9,153	...	...	...	...	...	...	...	...	...	...	
...	431	9,793	...	...	...	...	...	...	...	...	...	...	
...	78	1,620	...	...	13 (*a*)	...	73	39	...	13	39	8,285	Includes 3 square miles surveyed topographically on 16-inch scale.
25	911	10,026	4·7	0·4	...	...	...	...	...	...	...	...	
...	...	...	...	...	545	...	1,164	339	2·5	...	...	1,40,919	
...	16	691	2	0·6	120	...	266	99	0·5	...	...	1,43,181	
...	145	5,774	2	0·8	...	...	...	...	...	...	...	...	
...	37	1,384	0·6	0·7	...	...	...	...	...	...	...	...	
30	55	1,122	2	0·8	...	...	...	...	...	...	...	...	
...	53	1,344	2	0·9	...	...	...	...	...	...	...	...	
...	24	229	4	1·2	...	...	...	...	...	...	...	...	
...	21	345	6	0·4	...	...	...	...	...	...	...	...	
...	11	161	4	0·9	...	...	...	...	...	...	...	...	
35	120	2,300	6	0·6	...	...	...	...	...	...	...	...	
...	359	5,076	9	0·6	...	...	...	...	...	...	...	...	
...	35	407	4	1·1	...	...	...	...	...	...	...	...	
...	23 (*b*) + 114 (*c*)	3,112	...	...	...	...	...	...	...	...	...	...	(*b*) Tea grants.
...	25 (*b*)	991	...	...	...	...	...	...	...	...	...	...	For extension survey.
40	16 (*c*) + 27 (*b*)	1,953	...	...	...	...	...	...	...	...	...	...	
...	19 (*b*)	750	...	...	...	...	...	...	...	...	...	...	
...	3 (*d*)	236	...	...	...	...	...	...	...	...	...	...	(*d*) Disforested area.
...	...	176	...	...	...	...	...	...	...	...	...	...	
...	6,366	...	...	...	5,346	...	...	...	...	4,585	...	...	
45	...	...	...	...	161	...	...	...	...	...	...	...	
...	...	...	...	...	54	235	97	...	...	...	...	...	
...	...	902	3	2·5	501	63	52	...	...	...	...	...	
...	...	2,729	1·4	7·4	302	113	130	...	...	...	...	...	
...	...	815	2	2·2	435	71	34	...	...	...	...	...	
					68 (*e*)								(*e*) Revision survey.
50	...	2,342	2·5	1·1	...	...	...	...	...	...	...	...	
...	504	2,715	0·1	0·1	607	174	381	...	...	...	...	...	
...	...	...	...	...									
55	...	...	...	...	1,913	...	...	...	...	...	...	...	

Summary of th

Scale of Survey.	Number of Party.	Locale of Field Operations.		Triangulation.					1st Class.			Secondary.			Tertiary.		Spirit-levelling Operations		
				Instrument used. Diameter in inches.	Area in square miles.	Square miles to each point trigonometrically fixed.	Square miles to each height.	Stations fixed.	Triangular error in seconds.	Error per mile in feet.	Stations fixed.	Triangular error in seconds.	Error per mile in feet.	Intersected points.	Error per mile in feet.	Miles levelled over.	Permanent bench-marks Stones embedded.	Trigonometrical stations connected with.
Inches to a mile.		Brought forward	56	...	2,300	...	...	...	...	...	...	...	...	...	...	...	...	...
4	18	Simla Hill States	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	18 Riverain Survey.	Ferozepore and Lahore	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Mooltan and Bahâwalpur	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Muzaffargarh, D. G. Khan and Bahâwalpur.	60	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	20 Forest Branch.	Burma Forests, Upper Chindwin and Myittha.	...	6	250	31·3	31·3	...	...	...	7	10	0·5	1	...	...	...	...
		Burma Forests, Pyinmana Division.	...	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Burma Forests, Magwe	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" " Mindôn	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" " Magwe and Mindôn.	65	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" " Aratôn	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Central Provinces, Mandla	...	5	534	...	...	...	...	...	166	...	...	180	...	...	...	...
		" " Chânda	...	6	810	17·0	17·7	...	...	...	24	14	0·6	24	1·5	1,057	...	12
		" " Sambalpur.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Bengal, Singhbhum	70	6	325	7·4	7·4	...	...	...	29	13	0·7	15	1·3	...	...	...
		" Hazâribâgh	...	7	57	2·6	2·6	...	...	...	5	6	0·9	17	1·5	...	...	...
		Punjab Hazâra	...	7	200	2·2	2·2	...	...	...	19	29	0·9	73	3·1	...	...	...
		" Jubbal and Tarhoch	...	6	30	6·0	6·0	...	...	...	1	4·5	4·0	4	2·0	...	...	...
		U.-P. Agra and Oudh-Kheri-Nepal.	...	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Upper Burma Ruby Mines	75	5 & 7	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		TOTAL	...	...	4,512	...	...	...	...	...	...	...	...	...	...	...	...	...
2	3	Pegu and Hanthawaddy	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	12	Sind	...	6,7&8	2,027	31	31	...	...	...	35	8	0·2	97	0·2	...	...	...
	14	Allahabad	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	18	Montgomery (Tah. Pakpattan).	80	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Montgomery and Lahore	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Simla Hill States	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Det.	Central Provinces, Jubbulpore.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Provincial Surveys.	Assam, Kâmrûp	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		TOTAL	85	...	2,027	...	...	...	...	...	...	...	...	...	...	...	...	...
1	3	Pegu, Hanthawaddy and Toungoo.	...	6	1,530	20·6	20·6	...	...	...	38	8	0·7	27	0·8	...	...	...
		Toungoo	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Thayetmyo and Prome	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	10	Upper Burma	...	6	3,842	6·1	6·7	...	...	...	53	5·4	0·2	372	0·4	...	...	...
	11 & 21	" "	90	6	1,489	3·9	4·1	...	...	...	26	15·8	0·2	354	0·6	...	...	...
	14	Lushai	...	6	851	6·2	6·2	...	...	...	40	20	0·4	521	...	...	...	...
	15	Sind	...	6	1,215	81	110	...	...	...	15	4	1·2	68	4·5	...	...	...
	18	Simla Hill States	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		TOTAL	...	...	8,927	...	...	...	...	...	...	...	...	...	...	...	...	...
½	12	Sind	95	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	15	Kashmîr	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	15	N.-W. Frontier	...	8	183	...	...	...	...	...	8	...	...	...	...	...	...	...
		TOTAL	...	...	183	...	...	...	...	...	...	...	...	...	...	...	...	...
¼	11 & 21	Upper Burma	...	6	3,740	...	...	...	...	...	23	11·2	0·3	168	0·7	...	...	...
	15	N.-W. Frontier	100	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		TOTAL	...	...	3,740	...	...	...	...	...	...	...	...	...	...	...	...	...
⅛	15	N.-W. Frontier	...	...	80,050	...	...	...	...	...	...	...	...	...	...	...	...	...
	25	India	...	...	...	...	...	...	...	...	...	...	...	...	...	259 (g) 16 (h)	40	4
		GRAND TOTAL	104	...	99,496	...	...	...	...	...	...	...	...	...	...	...	...	...

[illegible]ield Parties dur[illegible]ng the y[illegible]e year 1901-02—contd.

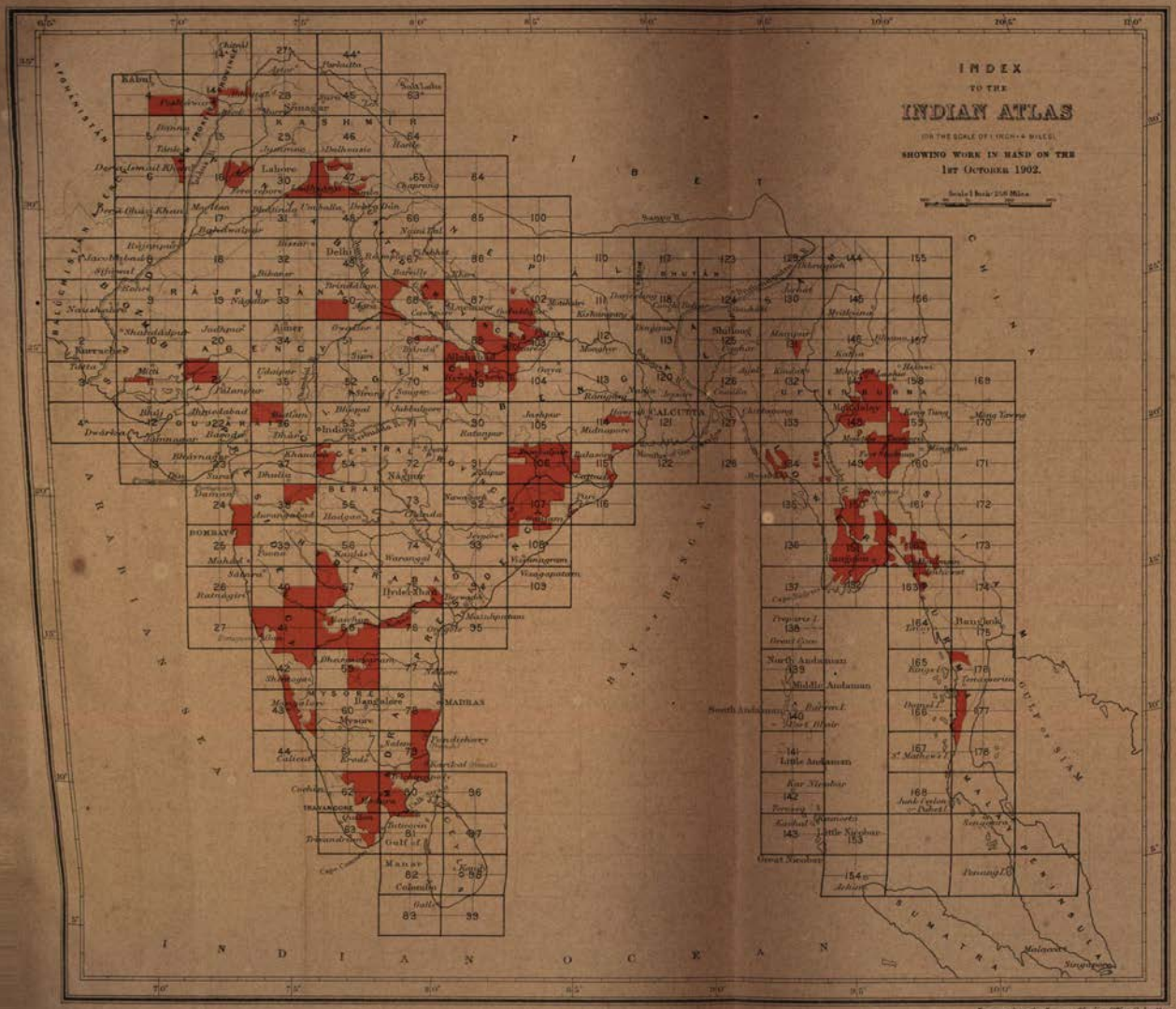
					DETAIL SURVEY.					RECORD-WRITING.			Remarks.
	Area in square miles.	Number of stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error per mile.	Area in square miles.	Plane-table fixings per square mile.	Linear miles of test lines.	Villages.	Average size of fields.	Area in square miles.	Villages.	Fields.	
56	...	...	...	...	1,913	...	...	...	...	...	...	...	
...	...	...	...	...	23	30	...	...	...	...	...	...	
...	1,888	1,548	7	0·3	...	...	...	...	...	...	...	...	
...		2,176	6·5	0·3									
60		1,012	6	0·3									
...	884	15,581	8·4	3·7	266	129	110	...	...	...	...	...	
...	12	111	...	...	10	156	3	...	...	...	...	...	
...	280	5,208	8·4	7·8	410	112	197	...	...	...	...	...	
...	95	2,198	3·4	5·0	...	...	...	...	...	...	...	...	
65	375	7,406	7·0	5·9	...	...	...	...	...	...	...	...	
...	...	...	...	...	38	69	41	...	...	...	...	...	
...	132	799	5	2·3	699	155	194	...	...	...	...	...	
...	231	1,895	...	2·4	725	118	352	...	...	...	...	...	
...	10	76	2	0·2	...	...	...	...	...	...	...	...	
70	20	105	0·04	0·3	369	200	110	...	...	...	...	...	
...	58	679	4	3·1	58	270	28	...	...	...	...	...	
...	...	...	...	...	12	...	...	...	...	...	...	...	
...	...	...	...	...	100	102	42	...	...	...	...	...	
...	5	42	0·1	1·2	...	...	...	...	...	...	...	...	
75	190	3,365	8	4·3	274	170	78	...	...	...	...	...	
...	...	...	...	...	4,897	...	...	...	...	...	...	...	
...	...	...	...	...	350	51·6	77	...	...	...	...	...	
...	1,763	7,402	0·3	0·4	1,597	25·1	931	...	...	...	...	...	
...	1,988	34,251	11	...	203	101	57	...	...	...	...	...	
80	...	2,550	6	0·2	...	...	...	...	...	...	...	...	
...	...	...	...	...	3,000(*f*)	6·7	...	...	...	...	...	...	
...	...	...	...	...	43	18	...	...	...	...	...	...	
...	...	...	...	...	1,936(*f*)	11	...	...	...	...	...	...	
...	...	...	...	...	12 (*e*)	...	...	...	...	...	...	...	(*e*) Tea grants.
85	...	...	...	...	7,141	...	...	...	...	...	...	...	
...	...	...	...	...	1,048(*f*)	...	...	...	...	...	...	...	
...	141	1,385	2·9	5·5	350	15	20	...	...	...	...	...	
...	...	...	...	...	1,555	13·6	...	...	...	...	...	...	
...	...	...	...	...	4,100(*f*)	6·9	768	...	...	...	...	...	(*f*) Revision survey.
90	...	...	...	...	2,663	7	500	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	1,696	...	*in situ*	...	...	...	...	...	
...	...	...	...	...	255	4	*in situ*	...	...	...	...	...	
...	...	...	...	...	11,667	...	...	...	...	...	...	...	
95	...	...	...	...	4,556	1·5	510	...	...	...	...	...	
...	...	...	...	...	2,787	174	*in situ*	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	7,343	...	...	...	...	...	...	...	
...	...	...	...	...	2,561	...	...	...	...	...	...	...	
100	...	...	...	...	5,151	...	...	...	...	...	...	...	
...	...	...	...	...	7,712	...	...	...	...	...	...	...	
...	...	...	...	...	60,450	...	...	...	...	...	...	...	(*g*) Double levelling.
...	...	...	...	...	...	...	...	...	...	...	...	...	(*h*) Branch lines.
104	...	...	...	...	104,794	...	...	...	...	4,585	...	...	

Statement showing the cost-rates

Number of Party.	Nature and *locale* of field operations.	Cost-rate per square mile.										
		Triangulation.	Traversing.	Detail survey and preparation of maps on scales of								
				1/2"	1"	1 1/2"	2"	3"	4"	6"	8"	12"	16"
	Topographical Surveys.	R	R	R	R	R	R	R	R	R	R	R	R
3	Lower Burma	5·5	37·3	...	...	...	26·8	72·5	...	...	...	...	...
10	Upper Burma	10·8	...	...	...	...	14·4	...	...	...	...	...	270·7
11 & 21	Upper Burma	1"=2·1 1"=10·4	...	...	3·1	...	23·3	...	...	...	...	...	...
12	Sind	6·6	14·9	...	...	3·1	...	17·1	...	...	...	...	...
14	Allahabad	...	30·2	...	...	...	...	16·4	...	...	...	...	...
15	Kashmír	...	...	...	...	4·8	...	...	...	...	...	...	...
	North-West Frontier	6"=26·8	...	...	...	...	...	...	...	196·0	...	...	...
	Sind	1"=1·8	...	...	...	...	9·3	...	...	...	...	...	...
18	Himalaya	...	2"=28·3 4"=18·4	...	...	...	10·1	53·7	74·3	...	...	...	...
	Forest Surveys.												
9 & 19	Madras — Forest	5·0	14·7(*f*)	...	...	...	...	...	59·0	...	...	...	...
	Madras — River	16·0	7·0(*f*)	...	...	...	...	...	...	...	...	...	...
17	Bombay	20·0	8·7(*f*)	...	...	...	...	...	63·8	...	136·1	...	...
20	Burma	15·0	53·5(*f*)	...	...	...	...	...	122·3	...	...	...	...
Forest Branch.	Burma	...	28·8(*f*)	...	...	...	...	...	85·9	...	...	...	...
	Central Provinces	2·0	7·0(*f*)	...	...	...	...	...	29·4	...	...	...	...
	Singhbhum	1·1	27·7(*f*)	...	...	...	...	...	50·6	...	...	...	...
	Hazáribágh	6·6	13·6(*f*)	...	...	...	...	...	33·2	...	...	...	...
	Hazára (North-West Frontier)	7·5	...	...	...	...	...	...	...	...	...	...	...
	Jubbal and Tarhoch States (Punjab).	5·9	...	...	...		...	...	23·6	...	...	...	...
	Cadastral Surveys.												
Detachment.	United Provinces of Agra and Oudh.	...	29·8	...	...	...	...	...	...	...	...	...	71·2
Bengal Surveys 4.	Darjeeling	...	61·2	...	...	...	...	...	...	...	...	...	163·8
	Patna	...	53·0		...	...	...	...	...	...	...	...	...
	Monghyr	...	37·1	...	...	...	...	...	...	...	...	...	68·1
	Purnea	...	23·5	...	...	...	...	...	...	...	...	...	120·4
	Bhágalpur	...	26·2	...	...	...	...	...	...	...	...	...	...
	Gaya	...	39·0	...	...	...	...	...	...	...	...	...	...
	Backergunge	...	61·9	...	...	...	...	...	...	...	...	...	170·8
	Sonthal Parganas	...	43·8	...	...	...	...	...	...	...	...	...	...
	Singhbhum	...	31·9	...	...	...	...	...	...	...	...	...	...
	Ranchi	...	60·5	...	...	...	...	...	...	...	...	...	...
7	Upper Burma, Lower Chindwin.	...	...	...	...	...	...	...	...	...	...	...	115·4
	„ „ Pakôkku	...	57·5	...	...	...	...	...	...	...	...	...	...
	Lower Burma, Sandoway	...	172·5	...	...	...	...	...	...	...	...	...	209·0
	„ „ Kyaukpyu	...	172·5	...	...	...	...	...	...	...	...	...	...
	Traverse Surveys.												
Detachment.	Central Provinces	...	24·5	...	...	...	...	9·5	...	...	...	...	...
Provincial Surveys.	Kámrúp	...	48·0 48·0(*n*)	...	...	...	...	36·2	...	...	...	...	...
	Darrang	...	06·2 86·3(*n*)	...	...	...	...	...	...	...	...	...	...
	Nowgong	...	72·4(*n*)	...	...	...	...	...	...	...	...	...	...
	Sibságar	...	76·6(*n*)	...	...	...	...	...	...	...	...	...	...
	Sylhet	...	187·7	...	...	...	...	...	...	...	...	...	...

Field Parties during the year 1901-02.

Cost-rate per square mile.					
Cadastral Survey, including traversing, detail survey, and mapping.	Stone embedding.	Records (*Khanapuri*).	Completion of Vernacular records assessment, statistics, etc.	Total cost, inclusive of charges for instruments to Provincial Governments.	Remarks.
Annas.	R	R	R	R	
...	...	...	...	90,184	(*a*) Includes R591 cost of the portion of the Party working in the Bangalore Drawing Office, and R3,143 expended on revision of Maymyo City, 19·18 square miles on 16-inch scale.
...	...	...	...	1,05,927 (*a*)	
...	...	...	...	1,26,075 (*b*)	(*b*) Includes R32,855 on miscellaneous and compilation works.
...	...	...	...	92,353	(*c*) Includes R1,278 cost of arrears of Lushai triangulation.
...	3·1	...	...	70,983 (*c*)	(*d*) Includes R24,897 expended on 42 square miles of cantonment surveys on 12", 48" and 60"; R9,275 on Baluchistán settlement, R32,380 on Frontier surveys.
...	...	...	...		(*e*) Includes R30,113 for Riverain surveys; R7,731 on Simla City survey.
...	...	...	...	1,25,120 (*d*)	(*f*) Linear miles.
...	...	...	...		(*g*) Inclusive of publication charges.
...	...	...	...	1,00,914 (*e*)	(*h*) Includes R4,232, cost of 1,893 miles of boundary survey and R1,836, cost of 1,057 miles of levelling.
...	...	...	...	91,625	(*i*) Includes R4,635 cost of Cawnpore Municipality Survey; R4,266 cost of Fyzabad and Ajodhya Town Survey; R320 cost of Fyzabad Cantonment survey, and R3,794 cost of Road surveys.
...	...	...	...	7,483	
...	...	...	...	71,364	(*j*) Includes R24,669 on miscellaneous surveys; R15,911 on standard mapping; R58,905 on reproduction of village maps R1,420 on *Thâna* maps and R7,684 on Orissa and Bihár *Badasi*.
...	...	...	...	1,74,283 (*g*)	
...	...	...	...	29,009 (*g*)	(*k*) Includes R13,030 on completion of arrears of other parties, revision of maps and preparation of fresh traces and area statements and other Miscellaneous work for Settlement Department.
...	...	...	...	53,328 (*h*)	
...	...	...	...	19,568	(*l*) Includes R312 cost of marks for Pakókku City survey.
...	...	...	...	3,090	(*m*) Includes R7,378 charge of Drawing Office.
...	...	...	...	1,740	(*n*) For Tea grants.
...	...	...	...	2,538	(*o*) Includes R1,642 on standard mapping; R13,865 on maintenance of Records and R2,783 on Boundary Commission.
...	·7	...	...	197,304 (*i*)	
...	...	...	...		
...	...	...	...		
...	...	53·3	...		
...	...	68·3	...		
...	...	...	...	10,59,900 (*j*)	
...	...	...	...		
...	...	102·5	...		
...	...	...	...		
...	...	...	...		
...	...	...	...		
3·0	...	...	5·7	82,716 (*k*)	
...	·4	...	...	44,896 (*l*)	
6·34	2·8	...	20·0	34,604	
...	2·8	...	...	25,425	
...	...	...	...	43,232 (*m*)	
...	...	...	...		
...	...	...	...		
...	...	...	...	33,497 (*o*)	
...	...	...	...		
...	...	...	...		
...	...	...	...		



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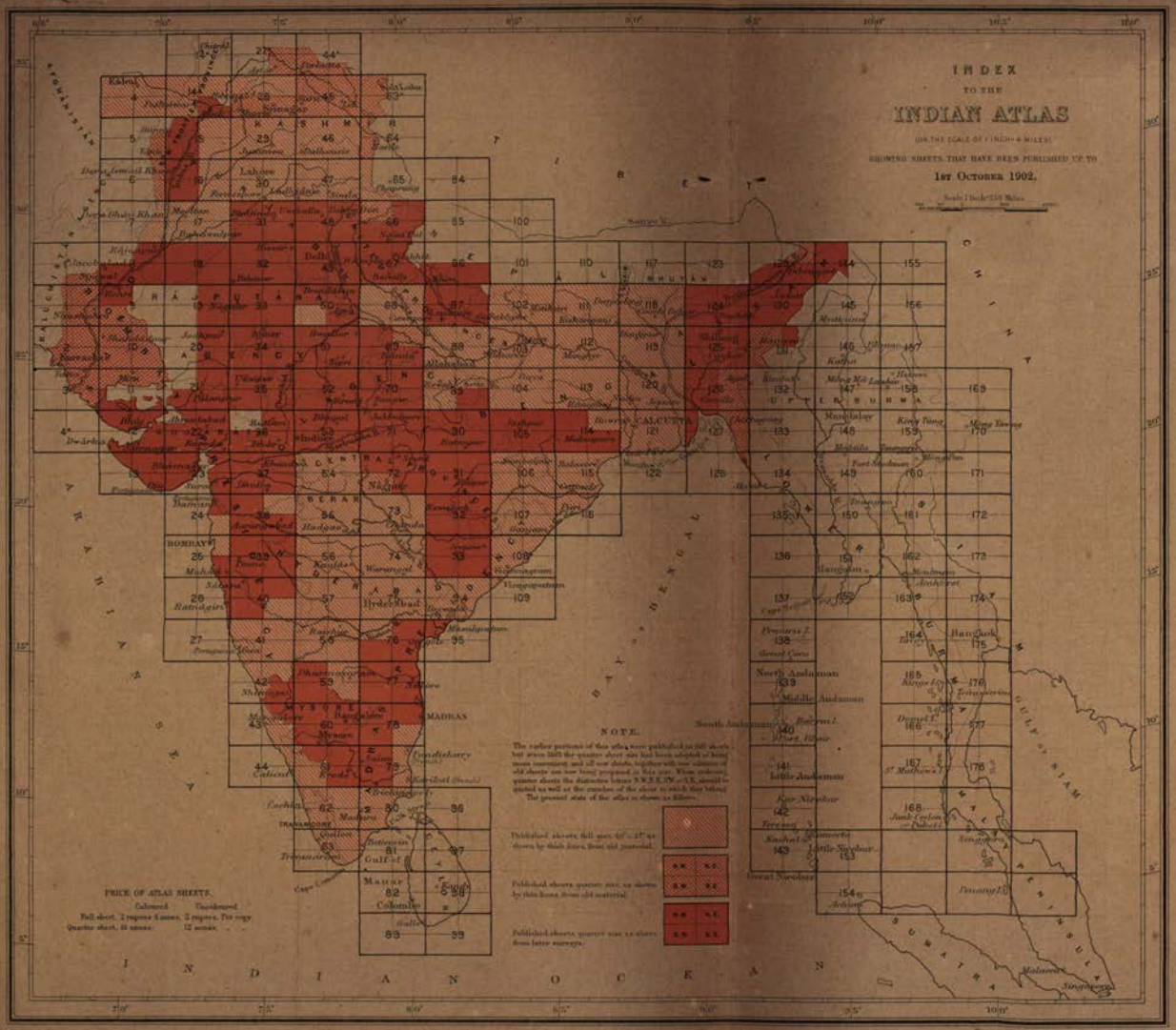

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APPENDIX.

Note on Surveys in the United Provinces of Agra and Oudh, BY CAPTAIN W. M. COLDSTREAM, R.E.

Revenue Surveys in these Provinces were originally carried out by two distinct branches, large scale village maps being prepared by the Settlement Department and small scale maps of large areas by the professional Revenue Survey Department.

During the settlement of a district the Settlement Officer, after demarcation of village boundaries and determination of disputes connected with them, prepared a map for each village on the scale of 16 inches to the mile, or some nearly equivalent scale of local units. The standard of measurement was in all cases the local *bigha*, which varied in nearly every district, and often in different parts of the same district, and rarely bore a simple proportion to the acre, which was in use by the professional survey and in which all English statements were compiled. At first the village maps were mere eye sketches made on the spot by eye, as the dimensions of each field were measured and recorded, but in 1852 the use of the plane-table was introduced, and the resulting improvement in the map was very marked. The agency employed was generally that of *amins*, but in some districts the *patwaris* did the whole or a part of the plane-table survey with considerable success.

The work of the professional Survey Department which dates back to 1833, was the preparation of maps on the scale of 4 inches to the mile based on theodolite traverse data. Reductions, on the 1-inch scale, were afterwards prepared in the form of standard sheets, representing areas included between parallels of latitudes 15 minutes apart, and meridians 30 minutes apart. With the 4-inch maps, the Revenue Survey also provided statements giving statistical information, such as the total areas of villages, the number of houses, ploughs, wells, etc. Practically the whole of the Province except Jhánsi and Kumaun was surveyed in this manner by 1870, and between 1877 and 1884 the districts of Saháranpur, Muzaffarnagar, Meerut, Bulandshahr, Aligarh and the southern *parganas* of Mirzapur were surveyed topographically on the 2-inch scale. Unfortunately "the records of some 13 districts were lost or practically destroyed during the mutiny and consequently no proper maps of these districts have been since available, the only ones existing, being skeleton district maps on the scale of half an inch to the mile." *

In 1871 the work of the two branches was amalgamated, and the modern methods of cadastral survey introduced.

The procedure was as follows:—

After demarcation of village boundaries by the district authorities, a party of the Survey of India ran theodolite traverses along the boundaries of each village, and on the skeleton plots thus obtained, carried out the detail survey on the scale of 16 inches to the mile of each village by the methods of chain survey, the use of the plane-table as a survey instrument being restricted to the delineation of topographical features, village sites, etc.

The survey party also prepared the field book or *khasra* of each village, the officer in charge of the survey being responsible for the correct numbering of the map and field book and for the entries in the area, crop and irrigation columns. The columns for the particulars of uncropped land were also filled in by the survey party, but the entries were afterwards checked by the Settlement Officer. The work of the party, both survey and record-writing, was caried out by sub-surveyors and *amins*, the cost of the strictly professional establishment being borne by the Imperial Government. The districts of Agra, Muttra, Bánda, Hamírpur and Moradabad were surveyed in this manner, and their village maps were reproduced by lithography, standard sheets on the 1-inch scale being afterwards compiled from the village maps.

Between 1877 and 1886 much the same system was applied to the survey of the permanently settled areas, in districts Benares, Mirzapur, Ghazipur, Jaunpur and Ballia. For this a code of instructions was drawn up by Sir Charles (then Mr.) Crosthwaite, and under it the survey party prepared cadastral village maps on the 16-inch scale and area books showing in acres, the area of each field. These were handed over to the settlement party which then made out and subjected to careful and repeated attestation the papers which constitute the record-of-rights for each village. Towards the end of the operations, this system was slightly modified by associating the settlement and survey parties in the preparation of the village papers. Operations were carried on in two or more districts at the same time, and the average duration for each district was about 4½ years. One *tahsil* of Benares district which forms a part of the family domains of the Maharaja of Benares, and for which separate arrangements were made, those portions of Ballia for which a new record had recently been prepared in the Azamgarh Settlement, and all the upland parts of Mirzapur were excluded from the survey. The area remaining was 5,448

* Note on the state of Topographical Surveys by the Surveyor-General in the annual report of the Survey of India for 1899-1900.

square miles and the total cost of survey was ₹10,16,532 or about ₹186 per square mile. The expense was high owing to the minute sub-divisions of the cultivation and the complexity and number of proprietary holdings and shares.

The cost of these surveys was at first divided equally between the Imperial and Local Governments, but after 1884 the Local Government bore a percentage of the expenditure corresponding to the percentage of land revenue assigned to it. Both maps and records-of-rights were put to the test of constant production before the Courts in dispute cases, and were proved to have attained a very high degree of accuracy.

From 1886 to 1894 this system of survey combined with the writing of certain of the records was used in the settlement of Dehra Dún, Gorakhpur, Basti, Jhánsi (excluding Lalitpur), and Garhwál. In the last named district only the cultivated parts were surveyed, and the small size of the fields necessitated the adoption of the 64-inch scale, and in Jhánsi the system was modified by the employment of *patwaris* on the survey of the fields.

In 1893 Mr. Darrah, who had inspected the maps and records of several districts in which settlement was about to fall due, submitted, in consultation with Colonel Sandeman, the Deputy Surveyor-General, and Mr. Freeman, the officer in charge of the survey party, working in Garhwál, a scheme for the preparation of maps and records by *patwari* agency. After a conference of officers at Naini Tal in 1894 the greater part of this scheme, slightly modified by the experience gained by Mr. Fuller in the *patwari* surveys of the Central Provinces, was accepted, and in 1894 the system of local surveys by *patwari* agency was introduced, which with some modifications is still in force.

Under the new system, after demarcation of village boundaries, the preliminary traverse was executed by a professional party of the Survey of India and at the close of each year's work, skeleton plots of each village were made over to the Land Records Survey, which was instituted as a branch of the Department of Land Records under the Board of Revenue, to carry out the cadastral survey and the preparation of records in the following manner:—

In each district coming under survey, the operations were placed in charge of the Collector of the district, or of the Settlement Officer (when the latter was appointed), and an officer of the Provincial Service of the Survey of India, whose services were lent to the Local Government, was appointed as Survey Officer to carry out the work. The Survey Officer, who was assisted by a staff of professional inspectors, estimators and draftsmen, began operations in October by training the *patwaris* in survey, after which each *patwari* surveyed the villages in his circle on the skeleton plots supplied by the traverse party, the methods of survey, check survey and supervision being those of the Survey of India. After the survey of a village the *patwaris* prepared in the field, a *khewat* or list of proprietors and a *khasra* or field book for each village, leaving the area columns to be filled in in office. At the beginning of the rainy season the *patwari* came in to the survey office and after being trained in tracing and estimating, assisted in the preparation of three traces of his village maps, and of village area statements, giving the area of each field or plot of land. He then, under the supervision of the Survey Officer and his staff, completed his field books and prepared a complete preliminary record-of-rights for each village. The Survey Officer also made a preliminary soil classification, but in 1899 this was discontinued, and the soil column of the field book was filled in by the Settlement Department.

One of the three traces was used by the Settlement Officer during his inspection, and at the close of the settlement operations, the second trace was filed in the *tahsil*, and the third made over to the *patwari* and kept by him unaltered as a record of the settlement map. From this copy the *patwari* himself prepared a fourth trace, on which to enter the alterations required from time to time. The original village maps were made over to the Survey of India and standard one-inch maps were compiled from them in a drawing office located at Mussooree.

In professional matters, and in matters of professional establishment, all cadastral surveys were placed in charge of an officer of the Imperial Service of the Survey of India whose services were lent to the Local Government, as Superintendent, Land Records Surveys, and who was also employed in arranging for and carrying out such special surveys of towns or important boundaries as were required by the Provincial Government. The Deputy Surveyor-General was also empowered to inspect the different district survey parties from time to time, to ensure the work being maintained at a professional standard.

In 1899 the system was modified by the transfer of traverse and mapping operations to the control of the Superintendent under the Provincial Government, the head-quarters of the traverse party and the drawing office being moved from Mussooree to Naini Tal, and the combined traverse, cadastral and mapping operations together with such special surveys as were carried out by the Superintendent being termed the Provincial Surveys. As regards professional matters in connection with traverse and mapping sections, the Superintendent was made directly responsible to the Deputy Surveyor-General, and in consideration of their value for cartographical purposes, the cost of the traverse operations, at the rate of ₹30 per square mile of area traversed each year, was refunded to the Provincial Government by the Survey of India, which also continued to pay for the cost of the drawing office.

At the same time an important change in the conduct of cadastral operations was introduced.

Up to 1899 each *patwari* in a tract under survey was given one year in which to complete the survey and record of his circle, but as this arrangement threw heavy work on

the *patwaris* and allowed barely sufficient time, the survey programmes were liable to be upset by any cause which took the *patwaris* off survey duty for even a short interval. On these grounds the two years system was introduced by which each *patwari* was allowed two years in which to complete his maps and records. On this plan the survey operations in a district extended during the first year over an area of about 800 to 1,000 square miles, rather more than half the work in this area being completed the first year and the remainder during the second year, when an additional area of some 400 to 500 square miles was entered. The two years' system, though giving better results and securing a more thorough training for the *patwaris*, has increased the cost of operations by a year's cost of establishment in each district, and by the emoluments of an Assistant Survey Officer, whose appointment was rendered necessary by the increased area over which operations extended. At first, the survey and record-writing of each village was completed within the two years irrespective of the date, but in 1900 the two years' system was modified by making the year of record in most districts under survey, the same for all the villages in a *tahsil*, thus necessitating the revision of all the work done the first year to bring it up to date during the second year.

In 1901 the traverse party having completed its work in districts in which survey was contemplated reverted from Provincial control and was amalgamated with a topographical party of the Survey of India, which has taken up the survey on the scale of two inches to the mile of districts of which there are no proper maps, a beginning being made with Allahabad. A small detachment of the traverse party was retained in Provincial employment to take up such additional traverse and other survey work as might be required in connection with cadastral surveys and surveys of Government roads and of towns or municipalities.

Since 1894 when the *patwari* system was introduced the following districts have been cadastrally surveyed in whole or in part, by the Land Records or Provincial Surveys :—

(1). Jhánsi (Lalitpur sub-division), (2) Bijnor, (3) Bahraich, (4) Kheri, (5) Sháhjahánpur, (6) Bareilly, (7) Sitapur (portions only), (8) Naini Tal (cultivated tracts only), (9) Meerut, (10) Pilibhít, (11) Gonda, (12) Farrukhabad, (13) Etáwah (portions of two *tahsils* only) and (14) Aligarh (scattered villages only).

A statement giving the years of survey, the cost-rates and other details for the above districts is attached.

The survey of Etah is also completed, but the records have not been made over to the Settlement Department.

The districts of Azamgarh, Mainpuri and Jálaun are now under survey.

The following special surveys, accompanied in some cases by records of holdings, have also been made by the Land Records and Provincial Surveys :—

Municipal surveys of Bareilly, Naini Tal, Sháhjahánpur, Tilhar, Mainpuri, Fatehgarh and Cawnpore, and the survey for Government of Fyzabad and Ajodhya, boundary surveys in connection with the Nepál frontier and the survey of roads in Farrukhabad, Etáwah and Mainpuri.

The surveys of portion of Allahabad civil station, of Kosi in Muttra and of Koil Atrauli, Háthras and Sikandra Rao, and of roads in Agra, Etah and Jálaun are now in progress.

In addition to surveys already mentioned the following hilly tracts have been surveyed topographically by parties of the Survey of India :—

1. The hill Native State of Tehri in Garhwál on the scale of ½-inch to the mile in 1851-1853.

2. Dehra Dún and the Siwálik hills on the 2-inch and 4-inch scales in 1873-76.

3. Kumaun and Garhwál on the 1-inch scale in 1886-1888.

District Surveys, including preparation of Settlement Records, executed by Land Records and Provincial Surveys between 1894 and 1902.

District.	Traversed by	Years of Survey.	System of Cadastral Survey.	Area surveyed, in square miles.	Total cost of Cadastral Survey.	Cost-rates in each district—Rupees per square mile.	Approximate cost-rates, including share of head-quarter charges.	Approximate cost-rate of Traverse.	Approximate cost-rate, including head-quarter charges and Traverse.	Remarks.
					₹	₹	₹	₹ a.	₹ a.	
Meerut . . .	Nos. 2 and 8 Parties.	1894-97	One year .	2,367	65,253	28 (1)	31 (1)		58 8 (1)	(1) Survey Officer's pay and allowances not included.
Jhánsi (Lalitpur only). .	,,	1894-97	,, .	1,059	66,307	63	70		97 8	
Bahraich . . .	,,	1894-98	,, .	2,042	1,29,555	58	63		90 8	
Sitapur . . .	,,	1895-96	,, .	196						
Kheri . . .	,,	1895-99	One year and two years.	2,108	1,43,885	68	75		102 8	
Sháhjahánpur . .	,,	1895-98	One year .	1,752	96,508	55	59		86 8	
Bareilly . . .	,,	1896-99	,, .	1,580	1,20,555 (3)	76 (3)	84 (3)	27 8 (2)	111 8 (3)	
Bijnot (four *parganas* only).	,,	1898	,, .	405	23,033	57	70		97 8	(2) The figures for each district cannot be separated; R27-8 is the average cost-rate.
Naini Tal . . .	No Traverse .	1897-99	,, .	101 (4)	45,000	445	523		523 0	(3) Includes cost of preliminary operations in Aligarh.
Pilibhít . . .	Nos. 2 and 8 Parties.	1898-1900	Two years .	1,072	81,571	76	86		113 8	(4) Scattered cultivation on 64-inch and 32-inch scale.
Gonda . . .	Nos. 2 and 8 Parties and Provincial Surveys.	1897-1901	One year and two years.	2,578	1,80,038	70	78		105 8	
Farrukhabad . .	Provincial Surveys.	1897-1901	Two years .	1,720	1,17,534	68	80		107	
Etáwah . . .	,,	1900-1901	,, .	...	...	...	...		...	
Aligarh (portions of two *tahsils*).	No new Traverse	1900-1901	One year .	...	...	...	...		...	
Etah	Nos. 2 and 8 Parties and Provincial Surveys.	1899-1902	Two years .	...	...	...	...		...	

District Surveys, including partial preparation of field books, executed by professional Survey parties, 1871—77.

District.	Years of survey.	Cost-rates per square mile.	Remarks.
		₹	
Agra	1872—76	160	
Muttra	1871—76	183	
Bánda	1874—80	192	
Hamírpur	1874—76	126	
Moradabad	1871—77	198	

District Surveys, including partial preparation of Settlement Records, executed by professional Survey Parties, 1877—94.

District.	Years of survey.	Cost-rates.	Remarks.
		₹	
Jaunpur	1877—81	209	
Ghazipur	1878—82	169	
Mirzapur	1879—83	151	
Ballia	1874—76	202	
	1880—84		
Benares	1882—84	152	
Gorakhpur	1883—88	167	
Basti	1883—88	225	
Jhánsi (excluding Lalitpur)	1888—90	54	By *patwari* agency; cost exclusive of traverse and record operation.
Dehra Dún	1890—92	...	
Garhwál	1889—94	...	

Abstract showing the approximate Magnetic values at Stations observed at by No. 26 Party during season 1901-02.

Serial No.	Name of Station.	Survey No.	Latitute.	Longitute.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
1	Pávdásan	53/3	24 29 20	71 53 50	33 35	E 1 10	0·3535	
2	Sáchor	53	24 45 20	71 45 50	33 45	„ 1 40	0·3535	
3	Dúthva	53	24 52 50	71 28 50	33 50	„ 2 0	0·3510	
4	Sheria Bheel	53/8	24 43 40	70 53 0	33 15	„ 1 40	0·3510	
5	Tar Lunian	53	24 39 0	70 31 40	33 55	„ 2 15	0·3520	
6	Islamkot	53	24 42 0	70 10 0	33 25	„ 1 5	0·3555	
7	Dipla	53	24 28 10	69 34 40	33 15	„ 2 0	0·3500	
8	Rahim-ki-bázár	53	24 19 0	69 9 0	32 40	„ 1 50	0·3510	
9	Kiria	53/4	24 20 0	68 46 40	32 35	„ 1 35	0·3505	
10	Lakhpat	53	23 49 20	68 46 40	31 45	„ 1 40	0·3525	
11	Mhur	53	23 33 20	68 56 50	31 25	„ 2 0	0·3535	
12	Nakhtrana	53/6	23 21 0	69 15 30	31 15	„ 1 35	0·3535	
13	Kalyánpur	53	23 13 40	69 35 40	30 40	„ 1 15	0·3570	
14	Bhimásar	53	23 11 20	70 9 50	30 20	„ 1 5	0·3545	
15	Lákadiya	53	23 20 30	70 34 40	31 10	„ 1 5	0·3530	
16	Adesar	53	23 33 20	70 59 10	31 25	„ 1 20	0·3560	
17	Várábi	53/2	23 47 50	71 26 20	31 45	„ 1 25	0·3555	
18	Diodar	53	24 6 30	71 46 10	32 15	„ 1 25	0·3560	
19	Sai	53/1	26 17 0	72 16 20	35 25	„ 2 5	0·3520	
20	Asolai	53	26 42 10	72 15 50	37 5	„ 0 15	0·3420	
21	Phalodi	53/5	27 7 40	72 21 30	37 35	„ 2 5	0·3440	
22	Nokh	53	27 33 30	72 15 20	38 25	„ 2 15	0·3455	
23	Ranjitpura	53	28 1 0	72 7 20	39 10	„ 2 15	0·3410	
24	Khangarh	53	28 22 10	71 42 50	40 5	„ 2 5	0·3395	
25	Derawar Fort	53	28 46 20	71 20 10	40 50	„ 2 45	0·3350	
26	Reti	53/3	28 5 10	69 51 20	39 15	„ 2 45	0·3380	
27	Lunwára Tar	53	27 44 30	69 38 40	38 35	„ 2 30	0·3390	
28	Piareh-ka-Toar	53	27 18 20	69 32 20	37 50	„ 2 20	0·3405	
29	Jussio	53/1	26 48 40	69 29 20	37 0	„ 2 10	0·3425	
30	Tajal	53/2	26 52 50	68 59 20	37 5	„ 2 0	0·3420	
31	Mubárik Sháh Syed.	53	26 23 40	68 56 20	36 15	„ 1 55	0·3445	
32	Bakár	53/4	26 5 10	69 9 0	35 45	„ 1 55	0·3450	
33	Khipra	53	25 49 20	69 22 20	35 20	„ 2 0	0·3460	
34	Ránáhu	53	25 56 10	69 47 20	35 30	„ 2 5	0·3460	
35	Nusseer Areesur	53	26 9 20	70 7 30	36 0	„ 1 55	0·3455	
36	Sumrahu	53	26 29 0	69 59 40	36 35	„ 2 5	0·3445	
37	Samásata	53/7	29 21 10	71 32 30	41 20	„ 3 0	...	
38	Kárachi	53/1	24 51 20	67 1 30	33 30	„ 1 35	...	
39	Dabeji	53	24 48 50	67 29 50	33 30	„ 1 40	...	
40	Jhimpir	53/11	25 1 50	68 0 50	33 55	„ 1 40	...	
41	Hyderabad	53	25 22 30	68 22 30	34 30	„ 1 45	...	
42	Shahdádpur	53	25 55 40	68 37 50	35 25	„ 1 45	...	
43	Daur	53	26 27 40	68 23 20	36 20	„ 1 50	...	
44	Kandiáro Road	53	26 59 20	68 20 50	37 25	„ 1 45	...	
45	Khairpur	53/5	27 31 10	68 44 20	38 10	„ 2 0	...	
46	Ruk Junction	53	27 48 20	68 38 20	38 40	„ 2 0	...	
47	Lárkhána	53	27 32 40	68 12 10	38 30	„ 1 55	...	
48	Sita Road	53	27 2 30	67 51 10	37 30	„ 2 10	...	
49	Búbak Road	53/3	26 29 0	67 46 10	36 30	„ 1 50	...	
50	Sann	53	26 1 40	68 6 50	35 40	„ 1 50	...	
51	Petáro	53	25 32 0	68 19 10	34 45	„ 1 45	...	
52	Jhatpat	53/2	28 22 20	68 19 20	39 45	„ 2 10	...	
53	Bellpat	53	28 59 40	68 0 20	40 45	„ 2 25	...	
54	Sibi	53/1	29 32 50	67 51 30	41 40	„ 2 35	...	
55	Pano Ákil	53/5	27 50 50	69 6 50	38 45	„ 2 15	...	
56	Kharpur Daharki	53	28 2 40	69 41 30	39 5	„ 2 35	...	
57	Sádikabad	53	28 18 10	70 7 40	39 45	„ 2 30	...	
58	Khanpur	53	28 38 20	70 39 10	40 0	„ 2 15	...	
59	Chanigot	53/8	29 5 10	71 1 30	40 55	„ 2 30	...	
60	Asrani	53	29 31 30	72 8 10	41 55	„ 2 40	...	
61	Bakhshankhan	53	29 44 30	72 42 50	42 0	„ 2 35	...	
62	Rojhanwali	53/9	30 0 50	73 15 40	42 25	„ 2 35	...	
63	Orki (Sujáwalpur.)	53/4	30 8 50	73 54 30	42 40	„ 3 0	...	
64	Malaut	53	30 11 0	74 29 40	42 40	„ 2 45	...	
65	Bhuchchu	53/8	30 12 50	75 5 30	42 50	„ 2 40	...	
66	Alál	53	30 21 50	75 43 50	43 10	„ 2 45	...	
67	Patiála	53	30 20 40	76 24 0	43 5	„ 2 50	...	
68	Sirhind	53	30 37 40	76 22 40	43 30	„ 3 0	...	
69	Ladhowál	53	30 59 0	75 47 20	44 10	„ 2 55	...	
70	Kartárpur	53/3	31 26 10	75 29 30	44 45	„ 3 0	...	
71	Lahore	53/8	31 35 50	74 18 50	45 20	„ 3 0	0·3240	
72	Chánga Mánga	53	31 5 30	73 56 30	44 5	„ 2 55	0·3280	
73	Gámbar	53/2	30 45 20	73 19 50	43 40	„ 2 55	0·3285	
74	Chíchawatni	53/2	30 32 10	72 41 50	43 20	„ 2 50	0·3305	

Abstract showing the approximate Magnetic values at Stations observed at by No. 26 Party during season 1901-02—contd.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′	° ′	° ′	C.G.S.	
75	Kacha Khúh	39 2	30 22 40	72 9 10	43 5	E 2 35	0·3285	
76	Mooltan	" 3	30 10 40	71 27 50	42 45	" 2 50	0·3290	
77	Gíláwála	" 5	29 43 10	71 28 20	41 50	" 2 45	0·3325	
78	Gujránwála	42 6	32 9 40	74 12 0	45 55	" 3 5	0·3220	
79	Sambriál	" 5	32 28 10	74 21 20	46 15	" 3 15	0·3210	
80	Jummoo	" 1	32 43 0	74 51 20	46 25	" 3 25	0·3200	
81	Lála Músa	" 2	32 42 40	73 57 0	46 40	" 3 20	0·3190	
82	Domeli	42 2	33 2 10	73 28 0	47 0	" 3 30	0·3170	
83	Mankiala	" 1	33 29 0	73 14 40	47 30	" 3 40	0·3155	
84	Sarai Kála	43 5	33 44 40	72 49 10	48 0	" 3 40	0·3140	
85	Khairabad	" 4	33 54 10	72 13 10	48 5	" 3 45	0·3130	
86	Rashkai	" 2	34 7 0	72 1 20	48 35	" 3 40	0·3100	
87	Dargai	" 1	34 30 10	71 53 50	48 55	" 3 55	0·3095	
88	Pesháwar	" 3	34 0 40	71 33 40	48 15	" 3 45	0·3115	
89	Jand	" 7	33 26 20	72 0 50	47 35	" 3 35	0·3145	
90	Fatahjang	" 6	33 34 20	72 38 30	47 40	" 3 35	0·3145	
91	Massan	41 1	32 53 30	71 43 20	46 50	" 3 20	0·3155	
92	Kundián	" 4	32 27 30	71 28 20	46 55	" 3 25	0·3130	
93	Hadáli	" 5	32 18 20	72 10 20	46 5	" 3 25	0·3200	
94	Lilla	" 2	32 33 0	72 44 40	46 50	" 3 30	0·3180	
95	Khewra	41 3	32 38 0	73 0 10	46 55	" 3 10	0·3165	
96	Bherah	41 3	32 29 20	72 55 20	46 20	" 3 5	0·3205	
97	Hariah	41 4	32 34 30	73 19 30	46 35	" 3 10	0·3180	
98	Amritsar	" 7	31 38 10	74 51 30	45 0	" 3 0	0·3255	
99	Dháriwal	41 2	31 57 10	75 18 50	45 45	" 2 45	0·3220	
100	Pathánkot	" 1	32 16 30	75 38 40	46 0	" 3 30	0·3245	
101	Kesri	40 5	30 15 50	76 55 30	43 5	" 2 50	0·3340	
102	Virár	41 3	19 27 10	72 48 30	23 35	" 0 20	0·3640	
103	Dáhánu Road	" 2	19 58 40	72 44 40	24 5	" 1 20	0·3680	
104	Párdi	" 1	20 31 0	72 55 40	25 40	" 1 50	0·3645	
105	Sachín	41 9	21 4 40	72 52 40	26 35	" 0 35	0·3660	
106	Fort Songad	41 8	21 8 50	73 33 30	26 45	" 0 40	0·3685	
107	Ankleshvar	" 7	21 37 20	73 0 20	27 50	" 0 50	0·3650	
108	Nándod	" 6	21 53 20	73 28 30	28 10	" 1 10	0·3630	
109	Bodeli	" 4	22 16 20	73 42 50	29 25	" 1 15	0·3645	
110	Itola	" 5	22 9 10	73 9 40	28 40	" 1 10	0·3625	
111	Cambay	41 5	22 19 20	72 38 0	28 60	" 1 10	0·3615	
112	Bárejadi	" 2	22 53 40	72 40 20	30 10	" 1 5	0·3580	
113	Paránt(j	42 12	23 25 40	72 51 50	31 5	" 1 35	0·3585	
114	Jagudan	" 11	23 30 50	72 24 0	31 20	" 1 20	0·3565	
115	Pátan	" 9	23 51 0	72 8 10	31 50	" 0 50	0·3505	
116	Kherálu	" 8	23 52 40	72 37 10	31 40	" 1 20	0·3505	
117	Deesa	" 6	24 14 30	72 10 40	32 30	" 1 20	0·3555	
118	Roho	" 5	24 24 20	72 38 20	32 35	" 1 30	0·3555	
119	Pindwára	42 1	24 47 40	73 2 20	33 55	" 1 50	0·3525	
120	Ráni	42 7	25 21 10	73 18 20	34 30	" 1 30	0·3520	
121	Khángta	" 2	26 33 30	73 37 20	36 45	" 2 0	0·3470	
122	Múndwa	42 5	27 3 50	73 48 30	37 40	" 2 0	0·3450	
123	Bikasar	" 4	27 34 20	73 28 0	38 25	" 2 0	0·3430	
124	Bikaner	" 3	28 0 40	73 18 50	39 15	" 2 10	0·3410	
125	Dulmera	" 2	28 21 20	73 39 50	40 5	" 2 15	0·3390	
126	Mahájan	" 1	28 47 40	73 50 40	40 30	" 2 25	0·3375	
127	Súratgarh	42 5	29 19 30	73 54 30	41 25	" 2 35	0·3365	
128	Gachhipura	42 1	26 57 20	74 24 50	37 25	" 2 5	0·3465	
129	Sámbhar	42 1	26 54 20	75 11 10	37 50	" 2 20	0·3470	
130	Ajmer	42 3	26 27 30	74 38 30	36 35	" 2 5	0·3480	
131	Beáwár	" 4	26 6 40	74 18 40	35 55	" 1 50	0·3490	
132	Sojat Rd.	" 5	25 52 0	73 45 10	35 25	" 1 45	0·3495	
133	Rahoki Junction	42 9	25 24 30	68 28 0	34 30	" 1 45	0·3465	
134	Mirpur Khás	42 8	25 31 40	69 0 40	34 45	" 1 50	0·3465	
135	Dhoro Naro	" 7	25 29 50	69 34 20	34 45	... ...	... ...	
136	Bhávnagar	42 8	21 46 40	72 7 40	27 15	" 0 25	0·3670	
137	Ningala	" 6	22 1 30	71 42 20	28 20	" 1 10	0·3635	
138	Limbdi	" 4	22 36 30	71 47 30	29 5	" 1 15	0·3570	
139	Viramgám	42 13	23 8 10	72 3 30	30 30	" 1 15	0·3580	
140	Dhrángadra	42 1	22 59 50	71 28 30	29 50	" 1 10	0·3625	
141	Dolia	" 3	22 31 20	71 21 50	... ...	" 1 15	0·3605	
142	Morvi	42 1	22 49 30	70 51 10	30 0	" 0 45	0·3555	
143	Rájkot	" 3	22 18 20	70 48 40	28 45	" 1 10	0·3600	
144	Virpur	" 5	21 51 0	70 42 20	28 15	" 1 10	0·3595	
145	Jámnagar	" 2	22 28 30	70 4 20	28 55	" 1 20	0·3590	
146	Junágad	" 7	21 31 50	70 27 0	27 15	" 1 20	0·3590	
147	Veraval	42 1	20 54 20	70 22 30	25 45	" 1 10	0·3635	
148	Abu Road	42 4	24 29 0	72 46 40	32 55	" 1 35	0·3550	
149	Chital	42 7	21 44 40	71 12 40	27 45	" 0 40	0·3610	
150	Jám Jodhpur	42 4	21 54 10	70 1 50	27 45	" 2 5	0·3600	
151	Porbandar	" 6	21 38 10	69 36 20	28 10	" 1 20	0·3595	

Abstract showing the approximate Magnetic values at Stations observed at by No. 26 Party during season 1901-02—concld.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C. G. S.	
152	Dákor . .	22/74 1	22 45 10	73 9 10	29 40	E 1 40	0·3600	
153	Chancheláo .	„ 2	22 47 50	73 42 40	30 5	„ 1 10	0·3590	
154	Dohad . .	„ 3	22 50 20	74 14 50	30 0	„ 1 10	0·3600	
155	Bhairongarh .	25/74 4	23 9 0	74 46 40	30 25	„ 1 15	0·3715	
156	Jaora . .	24/76 2	23 38 0	75 7 0	31 40	„ 1 30	0·3590	
157	(Panth) Píplia .	„ 1	24 12 20	75 0 40	32 5	„ 0 50	0·3560	
158	Nim bahera .	24/74 3	24 37 20	74 41 40	33 45	„ 1 45	0·3535	
159	Kapasin . .	„ 2	24 51 30	74 18 40	33 50	„ 1 55	0·3530	
160	Mándal . .	26/74 6	25 26 50	74 35 10	34 20	„ 2 35	0·3485	
161	Naraina . .	26/76 4	26 47 30	75 11 50	37 45	„ 1 55	0·3470	
162	Jaipur . .	„ 2	26 55 0	75 47 0	37 40	„ 2 5	0·3465	
163	Arnu . .	„ 3	27 0 0	76 28 50	37 40	„ 2 0	0·3480	

Repeat Stations.

I	Udaipur .	... ...	24 35 33	73 41 57	33 10	E 1 30	0·3545	
II	Karachi . .	... ...	24 49 50	67 2 2	33 30	„ 1 40	0·3475	
III	Quetta . .	... ...	30 11 52	67 0 20	42 30	„ 2 50	0·3255	
IV	Baháwalpur .	... ...	29 23 27	71 40 37	41 30	„ 2 55	0·3340	
V	Ráwalpindi .	... ...	33 35 16	73 3 6	47 45	„ 3 40	0·3140	

NOTES.—The above values of Dip, Declination and Horizontal Force are uncorrected for secular change, diurnal variation, instrumental differences, etc., and are to be considered as preliminary values only.

Where blanks occur the observations have been rejected and will be repeated.

The Survey numbers refer to the published chart: thus No. 26/76 3 denotes No. 3 Station in the dotted square, the spherical co-ordinates of whose centre are 26° North Latitude and 76° East Longitude.

All Longitudes are referrable to that of Madras Observatory taken at its latest value, *viz.*, 80,° 14′. 47″ East from Greenwich.

Mean monthly readings of earth thermometers taken at the Trigonometrical Branch Office, Dehra Dún.

Depth in feet of thermometer bulbs below surface of ground.	Year.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
25·6	1901-02	78·16	77·68	77·42	76·90	76·26	75·70	75·10	74·90	75·02	75·45	76·28	76·91
	Mean, 1887—1901	77·12	77·10	76·91	76·53	75·87	75·13	74·46	74·13	74·16	74·59	75·96	77·04
12·8	1901-02	79·83	78·89	77·13	74·93	73·21	72·64	73·43	74·87	77·00	78·50	79·70	79·94
	Mean, 1887—1901	79·55	78·54	76·82	74·59	72·45	71·15	71·45	73·26	75·46	77·68	79·53	79·94
6·4	1901-02	80·01	77·53	73·27	69·17	68·58	70·67	74·35	78·10	81·95	82·24	82·03	81·46
	Mean, 1887—1901	81·91	76·33	71·99	67·89	65·86	67·08	71·72	77·20	80·84	81·84	81·69	81·85
3·2	1901-02	78·97	73·93	67·53	63·95	66·03	72·36	78·77	84·30	86·81	84·31	82·74	82·17
	Mean, 1887—1901	78·30	72·36	66·23	62·29	61·54	67·02	76·10	83·15	85·49	83·73	82·19	81·66
1·1	1901-02	77·20	70·46	61·35	59·60	64·38	73·87	80·32	88·94	90·53	84·91	83·15	81·76
	Mean, 1887—1901	76·33	68·37	60·13	57·29	59·08	67·38	78·72	86·93	88·59	84·41	83·32	81·15
Thermometer in shade.	1901-02	80·98	74·08	66·87	68·64	74·30	82·13	88·19	92·64	90·97	81·52	81·68	81·14
	Mean, 1887—1901	80·33	73·35	66·85	63·69	66·61	79·03	89·48	94·32	90·68	82·55	80·53	80·17

G. I. C. P. O.—No. 51 S. G.—15·5·03.—450.—C. W.

1903.

File No. 76 of 1903.

Serial No. 3.

GOVERNMENT OF INDIA.

DEPARTMENT OF REVENUE AND AGRICULTURE.

LAND-SURVEYS.

RESOLUTION.

No. 2—76-3.

Simla, the 26th August 1903.

SUBJECT.

Reviews the General Report on the operations of the Survey of India during the year 1901-1902.

G. C. Press, Simla.—No. 605 R. & A. D.—1-9-03.—975.—H. T.

No. 2—76-3.

GOVERNMENT OF INDIA.

DEPARTMENT OF REVENUE AND AGRICULTURE.

LAND-SURVEYS.

Simla, the 26th August 1903.

READ—

The General Report on the operations of the Survey of India Department during the year 1901-02.

RESOLUTION.

Field operations were carried on by three double and fifteen ordinary parties and two detachments; one party was employed on trigonometrical surveys; one double and six ordinary parties on topographical surveys; one double and two ordinary parties on forest surveys; one double and two ordinary parties on cadastral surveys; two detachments on traverse surveys; and four parties on scientific operations. In addition to the above, traverse and cadastral surveys were continued in the United Provinces by Local Agency under the general supervision of the Deputy Surveyor General. The total outturn of detail survey during the year amounted to 104,794 square miles, including 68,162 square miles of reconnaissance surveys on the $\frac{1}{4}$ inch and smaller scales. The total area of rigorous surveys on all scales was 36,632 square miles. The total area triangulated was 99,496 square miles, which includes 83,790 square miles triangulated in connection with reconnaissance surveys, while the total area traversed for cadastral purposes was 5,424 square miles.

2. Of the parties engaged on topographical operations, Nos. 11 and 21 Parties were amalgamated and were engaged in a topographical survey of the Shan States. No. 3 Party was employed in Lower Burma and No. 10 in Upper Burma, mainly in the work of compiling topographical maps from the cadastral sheets. No. 18 Party was employed on similar work in the Punjab. No. 14 Party was engaged on original topographical work in the United Provinces. The subject of topographical surveys in Burma has been under consideration during the year. The completion of the topographical revision of the cadastral maps, and the survey of tracts which have not been cadastrally surveyed, but which are likely to be developed and brought under cultivation in the near future, or of which maps are required for administrative, engineering or railway purposes, will, for some years to come, provide ample work for the two Parties which are at present at work in the Province; while it is desirable that the 1-inch survey, which is at present being carried on in the Shan States, should be continued along the whole of the tracts bordering on the Siamese and Yunnan frontiers. The three Parties which are now employed in Burma and the Shan States will therefore continue to carry on work there for the present, and the Surveyor General has been requested to prepare and submit in consultation with the Local Government a programme for their employment during the next five years. It is satisfactory that arrangements have been made for the topographical survey of certain districts in the United Provinces, of which topographical maps do not exist and cannot be provided by reductions of cadastral maps.

3. The question of the condition of the existing topographical maps of the country and of the measures to be taken for bringing them up to date is at present engaging the serious attention of the Government of India. In Burma and the Punjab a satisfactory commencement has been made in the work of compiling correct topographical maps from the cadastral sheets; but the facts stated in paragraph 50 of the present report indicate that elsewhere the district maps are in a most unsatisfactory condition. The attempt to keep up the maps in the manner there described has evidently led to unsatisfactory results, and it is obvious that more systematic arrangements will have to be made for the revision of topographical maps generally. The question is now being fully considered in consultation with the Surveyor General.

4. Paragraphs 46-68 of the Report deal with the state of work in the Drawing and Issue Offices at Head Quarters. The details of maps issued are somewhat difficult to follow, but it is stated that there are still a large amount of arrears to be worked off in the way of bringing sheets out of stock up to date for publication, and that the publication of the results of the surveys completed by the Department is being greatly delayed owing to the congestion of work. This congestion is in great measure due to the large and increasing amount of extra departmental work which the Survey Department is called on to undertake, and which interferes considerably with the ordinary work of the Department. It will be necessary to consider the desirability of either strengthening the Head Quarters Offices or of relieving them of the extraneous work by which they are at present overburdened. In any case, the necessity is apparent of introducing stricter rules as to the conditions under which such extra departmental work is to be attempted.

5. The Government of India are glad to observe that the recent changes in the organization of the Mathematical Instrument Office, besides resulting in considerable saving, have enabled the whole of the accumulated stores to be put into proper order.

6. The Government of India fully concur in the opinion expressed by the Surveyor General in paragraph 79 of the Report as to the desirability of exhibiting clearly the financial results of the working of the Head Quarters Offices in a regular profit and loss account, and it is hoped that the arrangements which are reported to be now under consideration will enable this to be done in the Report for next year.

7. In conclusion, the Governor General in Council again desires to acknowledge the manner in which the Department generally under the direction of Colonel Gore has endeavoured to cope with the large and increasing amount of work devolving on it.

ORDERED that the above Resolution be forwarded to the Surveyor General of India, the Inspector General of Forests, the Local Governments and Administrations noted in the margin and to the Foreign, Military and Public Works Departments, and that it be published in the Supplement to the *Gazette of India*.

Madras.	Burma.
Bombay.	Central Provinces.
Bengal.	Assam.
United Provinces of Agra and Oudh.	Coorg.
Punjab.	Berar.
	North-West Frontier Province.

J. O. MILLER,

Secretary to the Government of India.

Photogravure. Survey of India Offices, Calcutta, December 1903.

THE MIL-I-KASAMABAD, SEISTAN.

From a negative by Mr. G.P. Tate.

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1902-1903.

PREPARED UNDER THE DIRECTION OF

COLONEL ST. G. C. GORE, C.S.I., R.E.,

SURVEYOR-GENERAL OF INDIA.

CALCUTTA:

OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.

1904.

CALCUTTA:
GOVERNMENT OF INDIA CENTRAL PRINTING OFFICE,
8, HASTINGS STREET.

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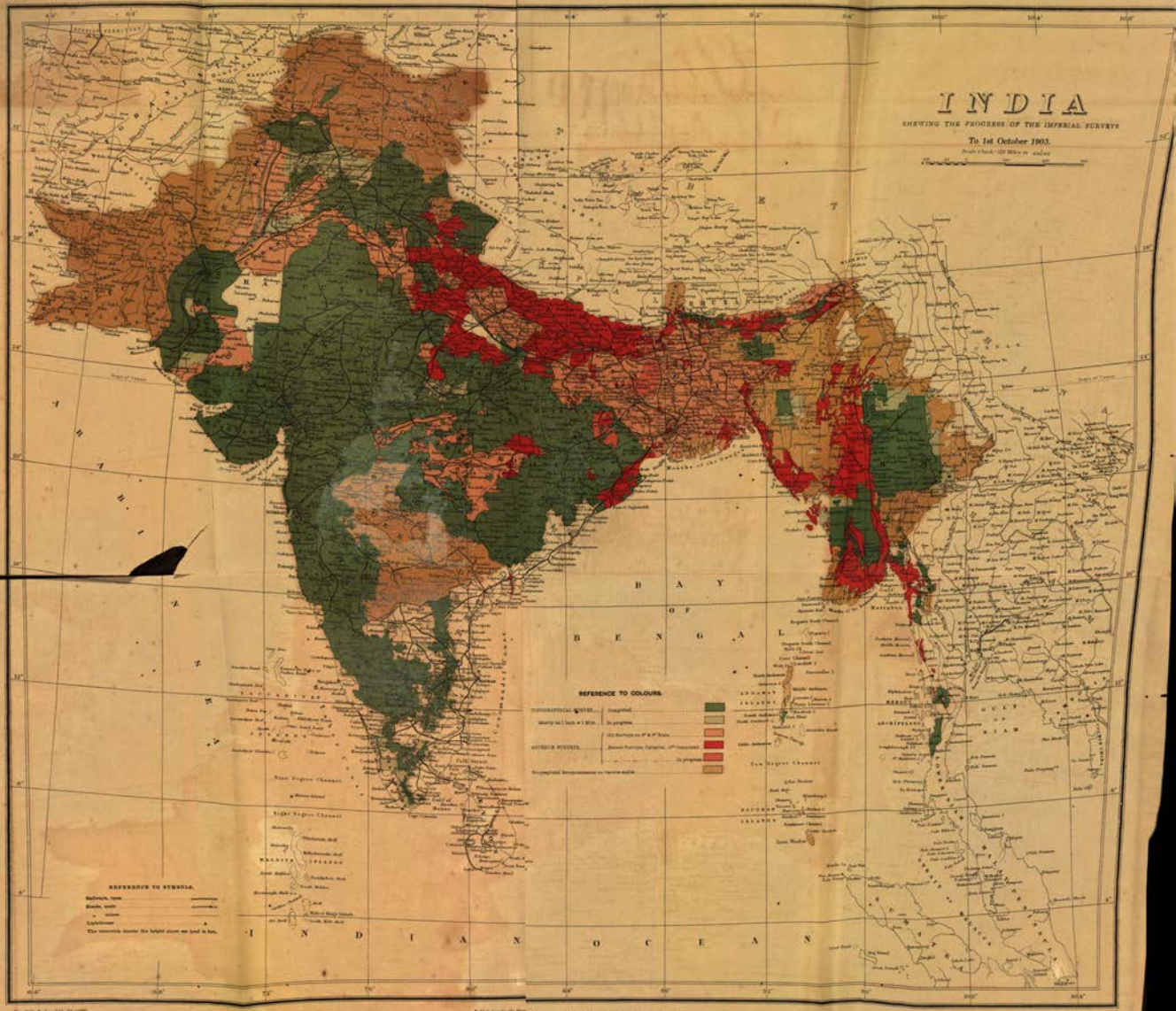
INDIA
SHEWING THE PROGRESS OF THE IMPERIAL SURVEYS
To 1st October 1903.
REFERENCE TO COLOURS.
REFERENCE TO SYMBOLS.
B A Y O F B E N G A L
I N D I A N O C E A N

Published under the direction of Colonel S. G. Burt, C.S.I., R.E., Surveyor General of India.

Reg. No. 699-S. 04.

GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1902-1903.

PART I.

SUMMARY.

ADMINISTRATION.

The operations of the department that are now reported on are for the survey year ending 30th September 1903.

2. Colonel St. G. C. Gore, C.S.I., R.E., Surveyor-General, directed the administration of the department and also superintended the Topographical Branch throughout the year.

The office of the Deputy Surveyor-General in charge of the Revenue Branch was held by Lieutenant-Colonel F. B. Longe, R.E., up to 6th October, when Colonel J. R. Hobday, I.A., returned from furlough and resumed charge of the office.

Mr. J. Eccles, M.A., officiated as Superintendent, Trigonometrical Surveys, throughout the year.

The office of the Superintendent, Provincial Surveys, Bengal, was held by Major R. T. Crichton, I.A., up to 6th August when he proceeded on three months' privilege leave and Lieutenant F. C. Hirst, I.A., held charge of the office up to the close of the year. Captain W. M. Coldstream, R.E., continued as Superintendent, Provincial Surveys, United Provinces, throughout the year.

Major P. J. Gordon, I.A., was in charge of Forest Surveys during the year. A draft resolution on the extension to Madras and Bombay of the rules for adjustment of expenditure on Forest Surveys applicable to the Bengal Presidency, and the amalgamation of the Forest Survey Branch with the Survey of India, has been issued by the Government of India and the revised rules contained therein will apply to the Forest Survey Head-Quarters and to all Forest Surveys in Provinces under the Inspector General of Forests from the 1st of April 1904 by which time it is hoped that the Governments of Madras and Bombay will agree to their being also applied to Forest Surveys in these Presidencies, thereby completing the scheme for the formation of a Forest Survey Branch under the Surveyor-General which has been under consideration for some time.

Inspection tours of Administrative Officers.

3. The Surveyor-General left Calcutta on the 7th April for Simla, but on his way he inspected No. 14 Party at Allahabad and the offices of the Superintendent, Trigonometrical Surveys, and Superintendent, Forest Surveys, at Dehra Dún, and that of No. 15 Party and the North-West Frontier drawing office at Mussooree, arriving at Simla on the 1st May. During his stay at Simla he inspected

the recess office of No. 18 Party on several occasions. He left Simla on the 24th July, and arrived at Roorkee the following day where he visited the Engineering College with a view to examine the capabilities of its map-reproducing establishment. He arrived at Dehra Dún on the 26th and again inspected the offices of the Superintendent, Trigonometrical Surveys, and Superintendent, Forest Surveys. On the 1st August he proceeded to Mussooree, and again inspecting the office of No. 15 Party and the North-West Frontier drawing office and other offices, returned to Calcutta on the 11th August. On the 1st September he again left Calcutta and proceeded to Bangalore where he inspected the recess offices of Nos. 3, 9 and 19, 10, 11 and 21 Parties, Godávari detachment, and the Bangalore drawing office; on the 16th he proceeded to Poona where he inspected No. 17 Party. He left Poona on the 20th for Simla to attend the committee appointed to report on the reorganization of the Survey of India with a view to arrange for bringing the topographical maps of India up to date, and form establishments for their periodic revision. On the 10th October he left Simla, and again visiting the Dehra Dún offices, arrived at Calcutta on the 17th October.

All the parties were inspected either by the Surveyor-General, or other administrative officers, during the year.

4. Colonel Hobday, I.A., Deputy Surveyor-General, inspected No. 2 and 8 Parties at Naini Tal in October 1902, and again in July 1903, when he was present at a meeting of the Board of Revenue to discuss future survey requirements. In November and December 1902, he inspected the following survey parties in the field; No. 14 Party at Allahabad, No. 18 Party at Mooltan, and the Central Provinces detachment at Garha near Jubbulpore. At the same time he visited Sámbhar to confer with Mr. Dane, the Salt Commissioner, and Dr. Noetling of the Geological Survey, and advise as to the conduct of a special survey required of the Sámbhar lake. He inspected No. 14 Party again in February and April; also the Central Provinces detachment at Jubbulpore. In May he proceeded to Rajahmundry to inspect the work of the Godávari survey detachment in the field, and in June he visited Simla to inspect No. 18 Party (Punjab). In July he inspected the Bengal survey camps at Dinapore and Dígha, and the Bengal drawing office at Calcutta on several occasions throughout the year. In September he accompanied the Surveyor-General to Bangalore where he inspected No. 3 Party (Burma) and the Godávari detachment. In September he proceeded to Shillong to inspect the Assam detachment and confer with the Local Government as to the future survey needs of the Province.

5. Mr. Eccles, Officiating Superintendent, Trigonometrical Surveys, visited Mussooree in June 1903 and inspected Nos. 22, 23, 24 and 26 Parties and the detachment of No. 25 Party. He also inspected No. 25 Party (Tidal and Levelling) and the Survey Training School, during the year from time to time.

6. Major Gordon inspected the detachments of Forest Surveys working in the Punjab, Bengal, Burma, and Assam, and No. 20 Party in the field in Burma, and again during recess at Dehra Dún. He also inspected Nos. 9 and 19 Parties at Bangalore and No. 17 Party at Poona.

FIELD PARTIES.

7. Field operations were carried on by three double and fifteen ordinary parties and two detachments; of these one was employed on trigonometrical, one double and six ordinary parties, and one detachment on topographical surveys, one double and two ordinary parties, and detachments on forest surveys, one double and two ordinary parties and one detachment on cadastral and traverse surveys and four parties on scientific operations.

8. The operations of the Forest Survey Branch, which are under the administration of the Superintendent Forest Surveys, are fully reported on in the Forest Survey Report and are therefore only briefly mentioned here.

The surveys carried on by local agency in the United Provinces of Agra and Oudh, which are under the general supervision of the Deputy Surveyor-General, have also been included in this report under the head of Cadastral Surveys.

9. In the following statement the whole of the operations are grouped according to the nature of the work on which the parties are employed :—

Statement of Survey Operations and Parties.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
				Inch. Mile.	
	Trigonometrical.				
24	Indian Triangulation	25	Captain H. Wood, R.E.	.....	Supdt., Trig.
	Topographical.				
3	Lower Burma	26	Mr. E. F. Litchfield „ P. J. Doran	1 = 1	D. S. G., Rev.
10	Upper Burma	27	Captain F. W. Pirrie, I.A. Lieutenant A. A. McHarg, R.E.	1 = 1	D. S. G., Topo.
11 & 21	Ditto	29	Captain C. H. D. Ryder, R.E. Mr. P. J. Doran	1 = 1	Ditto.
12	Sind	30	Mr. C. F. Erskine Lieutenant E. T. Rich, R.E.	2 = 1 1 = 1	Supdt., Trig.
14	United Provinces	31	Captain C. W. H. Symonds, I.A.	2 = 1	D. S. G., Rev.
15	North-West Frontier	33	Captain G. A. Beazeley, R.E. Mr. E. A. Wainright	Various	D. S. G., Topo.
18	Punjab	34	Major W. J. Bythell, R.E. Captain E. A. Tandy, R.E. Mr. W. Robert	Do.	D. S. G., Rev.
	Central Provinces	37	Mr. R. C. D. Ewing	2 = 1	Ditto.
	Forest.				
9 & 19	Madras Presidency	39	Captain C. L. Robertson, R.E. Mr. H. Todd „ G. T. Hall	4 = 1	
17	Bombay ditto	41	Mr. B. G. Gilbert-Cooper „ S. F. Norman	4 = 1 8 = 1 16 = 1	
20	Burma	42	Captain A. H. B. Hume, R.E. „ A. Mears, I.A.	4 = 1	Supdt., Forest Surveys.
	Bengal Assam Punjab North-West Frontier Jubbal and Tarhoch United Provinces Central Provinces Burma	44	Major P. J. Gordon, I.A.	4 = 1	
	Cadastral and Traverse.				
2 & 8	United Provinces	47	Captain W. M. Coldstream, R.E.	16 = 1	D. S. G., Rev.
4	Bengal	50	Major R. T. Crichton, I.A. Lieutenant F. C. Hirst, I.A.	16 = 1	Ditto.
7	Burma	53	Major G. B. Hodgson, I.A. Lieutenant C. P. Gunter, R.E. Mr. J. S. Swiney	16 = 1	Ditto.
	Godávari	56	Babu Nilmoni Chatterjee Mr. S. F. Norman (Jr.)	16 = 1	Ditto.
	Assam	58	Mr. T. Shaw	.....	Ditto.
	Geodetic.				
22 23	India	60	Lieutenant H. M. Cowie, R.E.	.....	Supdt., Trig.
	Tidal and Levelling.				
25	India	61	Captain H. H. Turner, R.E. Lieutenant F. B. Tillard, R.E. Mr. E. J. Connor	.....	Ditto.
	Magnetic.				
26	India	62	Captain H. A. D. Fraser, R.E.	.....	Ditto.

OUTTURN.

10. The total outturn of detail survey during the year amounts to 70,797 square miles, which includes 38,000 square miles of reconnaissance surveys on $\frac{1}{8}$-inch scale. The area surveyed during the previous year amounted to 104,794 square miles which included a reconnaissance surveys of 68,162 square miles. In the returns for the present year, however, the reconnaissance surveys done by the surveyors attached to the different expeditions and missions have not been taken credit for. The total area triangulated is 15,223 square miles, which is about the same as last year excluding the area done in connection with the reconnaissance surveys. The total area traversed for cadastral purpose is 10,067 square miles, *viz.*, 2,253 square miles in the United Provinces of Agra and Oudh, 6,884 square miles in Bengal, 799 square miles in Burma and 131 square miles in Madras.

TRIGONOMETRICAL SURVEYS.

11. The triangulation party (No. 24) having last year completed the Manipur Minor Meridional series, was employed during the year under review in extending the Great Salween principal series eastwards. This series of triangles emanates from the Mandalay Meridional series about the parallel of 24° Latitude. It will be carried eastwards up to the Salween river and then turning southwards will follow the course of that river, eventually joining on to the previously executed principal triangulation to the south. It will thus form a strong frontier series to support any extension of triangulation which may hereafter be required further eastward.

TOPOGRAPHICAL SURVEYS.

12. During the year under report no changes of the *locale* of operations of the Topographical Survey parties have taken place, the work being carried on in continuation of that of previous seasons.

13. In Lower Burma topographical work was carried on as in the previous year by No. 3 Party. Surveys were carried on in the Thayetmyo, Magwe, Henzada and Tharrawaddy districts and consisted of the supplementary survey of topographical detail omitted from the cadastral maps and the complete detail survey of those parts of the sheets in question which had not been touched by the cadastral operations. A good season's work was accomplished, 1,786 square miles of new detail survey and 2,934 square miles of supplementary topographical survey being completed.

14. In Upper Burma, No. 10 Party, as before, was engaged partly in new topographical survey and partly in supplementary survey to fill up the topographical deficiencies in the maps compiled from reductions of the cadastral sheets. In Burma, where hilly and broken ground is often much intermingled with cultivated areas, it is sometimes difficult to say whether work should be classified as new or as supplementary survey.

Work was carried on in the districts of Meiktila, Myingyan, Kyauksè, Sagaing, Pakôkku, Magwe and Minbu. A total area of 3,336 square miles of detail survey on the 1-inch scale was completed.

The station of Maymyo is increasing so rapidly that it has been found necessary to revise the large scale map of it which was prepared two or three years ago. The new roads, buildings and forest and other boundaries have been now surveyed and a second edition of the map is being brought out.

15. The Shan States survey which is being carried on by the amalgamated party, Nos. 11 and 21, progressed steadily during the year, the portion of the country under survey being that part of the Southern Shan States on either side of the Salween river between Latitude 20° and 21°. Taking into consideration the difficulties of the country the progress has been very satisfactory; an area of 2,432 square miles having been surveyed in detail on the 1-inch scale and a proportionate area of triangulation executed in advance.

16. The question as to the extent to which topographical surveys in Burma should be carried, which was alluded to in last year's report as under discussion, has now been decided by the Government of India. For Burma proper a 5 year programme for Nos. 3 and 10 Parties has been sanctioned. This embraces

a large area of the more important tracts of country, and it has been drawn up to meet as far as possible the wishes of the Local Government. On the completion of this the matter will be reconsidered as to what further area should be taken in hand. As regards the survey of the Shan States and the country contiguous to the Eastern Frontier, it has been decided to carry on the 1-inch topographical survey right up to the frontier.

17. The survey of Sind was continued by No. 12 Party, detail survey being carried on in the north-eastern portion of the division. The cultivated country was surveyed on the scale of 2 inches = 1 mile, an area of 1,946 square miles being so mapped while the desert area lying to the east was mapped on the ½-inch scale, the area thus completed amounting to 2,164 square miles, making a total of 4,110 square miles of completed survey. The usual triangulation and traversing in advance was also carried on.

The Geological Survey Department being anxious to make certain investigations into the problem of the supply of salt in the Sámbhar Salt lake, the Survey Department was asked to make a detail survey of the lake. This was undertaken by a detachment from No. 12 Party, and a complete survey of the lake and its surroundings on the scale of 2 inches=1 mile, comprising an area of 178 square miles, was completed. Lines of spirit levelling were run round and across the lake, so that a closely contoured map of the lake area has been made, thus giving the Geological Department the means of estimating the amount of water in the lake at any moment.

18. The survey of the districts of the Allahabad division of the United Provinces which was commenced in the previous year by No. 14 Party, has been continued. The work consists of a full topographical survey of the country in question on the scale of 2 inches=1 mile, the stations of the traverses on which the topography is based being carefully marked and preserved in order to be available should a cadastral survey be determined on at any future time. On account of the minute area of many of the villages, it has been found necessary to publish two editions of the maps, one on the 2-inch scale, showing village boundaries and a second a general topographical map on the 1-inch scale omitting these boundaries. The area completed during the year was 1,885 square miles.

19. No. 15 Party has been employed as in previous years on work required by the Military authorities. In addition to work on the frontier this party has now completed the survey of the hilly portion of Sind which was allotted to it, an area of 1,499 square miles having been mapped. The cantonments of Chakráta, Meean Meer, Umballa, Mooltan and Pesháwar with their bazars and also the bazars of Ferozepore were mapped, and the maps of the Khágan valley revised over an area of 1,033 square miles.

20. In the Punjab No. 18 Party continued the work on which it had been employed during the previous year. Supplementary topographical surveys were carried over an area of 3,653 square miles in parts of Montgomery, Lahore and Amritsar districts in order to render the maps compiled from the *patwáris* surveys available for general topographical purposes. Riverain surveys are at the request of the Punjab Government being carried on wherever the new policy of demarcating riverain boundaries permanently once for all has been carried out. These surveys are to enable such boundaries to be accurately relaid at any time however much the present course of the river may have shifted. The great difficulty in carrying them out satisfactorily is that these boundaries are, as a rule, not settled and demarcated until late in the working season and the marks are liable to be entirely obliterated by the first floods of the rainy seasons. Of these riverain traverses, 1,158 square miles were traversed during the season. The Simla Estate boundary survey is completed with the exception of a few sheets held over to enable the railway to be inserted and the greater part of the sheets have been fair drawn. This party is much hampered by a quantity of arrears of map drawing. It has been employed on several large scale operations such as the Simla and the riverain surveys, which entail the drawing of a very large number of sheets. All map draftsmen have to be specially enlisted and trained and with the present pay offered it is difficult to find and keep suitable men.

The Punjab Government is anxious that the work of preparing and issuing new topographical maps of the Province should be pushed forward with much greater rapidity than at present. This is of course very desirable, but unfortunately the Survey Department has no staff available for the purpose.

21. In the Central Provinces the detachment which has hitherto been employed on traversing forest excisions and *samindári* villages for the local authorities, having completed the greater part of the traverse work required, has been to a great extent employed in bringing out new topographical maps of the Jubbulpore and surrounding districts. These maps are being compiled from various sources, the forest surveys, the old revenue surveys and the local agency cadastral surveys, being all utilized as far as possible. These are filled up and worked together by supplementary topographical survey carried on in the field, thus furnishing good modern topographical maps. During the season 2,834 square miles were thus mapped and surveyed. It is hoped that this detachment may be increased in strength and raised to the status of a party as there is a very large area of country in the Central Provinces of which modern maps are badly wanted.

22. In the Appendix to the General Report of the Survey of India for 1899-1900 a note was given detailing the present state of the topographical maps throughout India, which pointed out to what a very great extent they were either obsolete or in need of revision. Excluding the greater part of the Province of Bengal, for which it is hoped that topographical maps may be obtained from the cadastral surveys which are likely to be undertaken, it may be said that there are over 200,000 square miles of country, of which entirely new topographical maps are required, while a further area of over 250,000 square miles requires either supplementary survey or revision to bring the maps up to date. The matter is at present engaging the attention of the Government of India, and it is hoped that arrangements may be made, which in the course of time will put the up-keep of the topographical maps of India on a permanent footing.

23. The total outturn for the year under the head of topographical survey on various scales from 1 inch upwards including both full and supplementary surveys, amounted to 22,646 square miles.

This is made up as follows :—

Surveyed on the 1-inch scale	. . . .	12,052	square miles.
„ „ 2-inch „	. . . .	9,895	„ „
„ „ 4-inch „	. . . .	699	„ „

FOREST SURVEYS.

24. The special surveys of Government forests were, as in previous years, carried out by detachments of the Forest Surveys, Bengal Presidency, and by No. 20 Party under the administration of the Superintendent, Forest Surveys, and the general control of the Inspector General of Forests, and by Nos. 9 and 19 Parties in Madras and No. 17 Party in Bombay. The Superintendent, Forest Surveys, held administrative charge of the latter parties under the control of the Surveyor-General as a preliminary measure to the formation of a special Forest Branch of the Survey of India which will, it is hoped, be completed early in 1904.

25. In Madras, Nos. 9 and 19 Parties continued the survey of forests in Kurnool, Cuddapah and South Canara on the 4-inch scale. Preliminary triangulation was also carried out in the Ganjam and Godávari districts. Further examination and revision was continued in North Coimbatore. The detachment employed on the survey of the Godávari delta was placed under the orders of the Deputy Surveyor-General, Revenue Branch.

An area of 1411 square miles was surveyed at a cost of ₹58 per square mile wihch is the average rate for three years.

26. In Bombay surveys were carried out in the Northern, Central and Southern circles, the survey of the forests in the last named being now complete. The triangulation of the Khándesh forests, where most of the work of the party will lie in the future, was commenced.

The outturn of the party for the year was, in addition to 1373 square miles of triangulation, 487 square miles of detail survey on the 4-inch, 240 on the 8-inch and 6 on the 16-inch scale, the cost-rates being ₹61, ₹130, and ₹137, respectively.

The rates, in spite of an increase in the cost of supervision, are less than those of last year and may be considered satisfactory.

Excluding Sind, proposals for the survey of whose forests have not yet been made, an area of over 4,000 square miles remains for survey and under favourable conditions should be completed in 1907 or 1908.

27. In Burma an area of 623 square miles of forests was surveyed on the 4-inch scale by No. 20 Party in the Upper Chindwin, Thayetmyo and Ataran

districts. A large area was also triangulated and traversed in advance for next season's detail survey. The cost-rates of triangulation and traverse survey were R3-2 and R44-7, respectively and continue to show a marked improvement but those of detail survey again show an increase, being R136 per square mile as compared with R122 in 1901-1902. The high cost-rates are fully explained by a decrease in the outturn which was due principally to the curtailment of the working season by the time occupied in the long river journey from and to the base, by the extremely difficult nature of the country and to sickness among the members of the party: unusually large non-effective charges also helped to augment the cost. It is confidently hoped that next year there will be a substantial improvement in the cost-rates, although it must be remembered that with a short field season of 5 months, which is all that the climate will admit of, and an average outturn of $3\frac{1}{2}$ square miles a man a month which experience shows cannot be exceeded in the difficult country of the Upper Chindwin valley if good work is to be done, it is impossible to work at the low rates which prevail in easier country and under most favourable conditions.

28. In addition to No. 20 Party two detachments of Forest Surveys were employed on survey work in the Irrawaddy valley, and in addition to some triangulation brought in an outturn of 303 square miles of 4-inch detail survey and 810 linear miles of traverse in the Bhamo, Ruby Mines, and Mandalay districts. The country was comparatively easy, and there was little sickness among the men. The cost-rates were R64 per square mile of detail survey and R37 per linear mile of traversing.

As explained in last year's report the cost-rates of these detachments cannot be well compared with those of No. 20 Party, the conditions being altogether different.

29. In the Central Provinces one small detachment completed the survey of Chánda, with the exception of the Cherla range the survey of which has not yet been sanctioned. The survey of the forests in the Central Provinces is now complete: it has for many years afforded a favourable field of operations, owing to the easy nature of the country, and to the facility for obtaining supplies and cheap labour. In all over 19,000 square miles of forest have been surveyed in these Provinces, and in addition to the special value of the surveys to the Forest Department they are now beginning to supply useful material for the revised 1-inch standard maps which are being compiled.

The outturn for the year in Chánda was 226 square miles at a cost of R26 per square mile of detail survey.

30. In Bengal a detachment commenced the 4-inch detail survey of the forests in the Kurseong, Darjeeling, and Kálimpong divisions of the Darjeeling district. In addition to triangulation and traversing 232 square miles were topographically surveyed on the 4-inch scale at a cost of R64 per square mile. The survey of these forests will be completed in 1903-04.

31. The survey of the forests in the Gáro Hills and Kámrúp districts were commenced by a detachment of Forest Surveys and in addition to traversing and triangulation an area of 134 square miles was topographically surveyed on the 4-inch scale at a cost of R98 per square mile. The difficulties attending the operations cannot well be exaggerated. Most of the surveyors as well as the *khalásis* imported from Chota Nagpur suffered severely from fever and dysentery and many were incapacitated often for weeks together. It was almost impossible to obtain local labour and the clearing of the traverse lines and of trigonometrical stations was a tedious and costly process. Existing triangulation and traverse stations were few in number and the forest blocks were much scattered.

32. In the Punjab the survey of the Jubbal and Tarhoch State forests was completed. A detachment was also employed on 4-inch detail survey in Gujrát and Ráwalpindi districts, where 100 square miles were surveyed at a cost of R34 per square mile. The detachment then proceeded to Hazára where 173 square miles were surveyed at a cost of R24 per square mile. A surveyor was also sent to Chamba to fix the positions of new boundary pillars.

33. In the United Provinces a small detachment surveyed 100 square miles in Kumaun, Garhwál and Naini Tal, at a cost of R30 per square mile.

34. The total outturn of Forest Surveys on various scales during the year amounts to 4,062 square miles of which 1,918 square miles were surveyed by the Forest Branch including No. 20 Party.

The total is made up as follows:—

	Square miles.
4-inch scale	3,816
8-inch scale	240
16-inch scale	6
TOTAL	4,062

The cost-rates were generally moderate except in the case of No. 20 Party in Burma and of the Forest detachment in Assam, where high rates were inevitable, owing to the natural difficulties of the area under survey, its unhealthiness and the cost of importing labour.

CADASTRAL AND TRAVERSE SURVEYS.

35. During the year under report there was one cadastral party in Burma, one in Bengal, and one in the United Provinces of Agra and Oudh.

36. In Upper Burma 606 square miles of Pakôkku district were cadastrally surveyed, and 455 square miles traversed, also 302 square miles were traversed in district Shwebo. In Lower Burma 74 square miles were cadastrally surveyed in district Kyaukpyu and 42 square miles traversed, thus completing the cadastral survey of the district.

37. In Bengal 6,884 square miles were traversed, 2,838 square miles cadastrally surveyed, and 2,620 square miles of record-writing completed, in districts Bhágalpur, Backergunge, Sonthal Parganas, Ránchi, Hazáribágh, Monghyr, Purnea, Rangpur, Midnapore, and Shahabad. An area of 12 square miles has also been traversed for the Calcutta suburbs survey, and 3 square miles surveyed in detail on the scale of 50 feet to the inch.

38. In the United Provinces Nos. 2 and 8 double party cadastrally surveyed 195 square miles in districts Mainpuri and Jálaun, and traversed 140 square miles in district Moradabad, and 155 linear miles along the high banks of the Rámganga and Dhela rivers for future cadastral survey; also the survey of the civil station of Allahabad on the scale of 200 feet to the inch, and the following towns for municipalities on the scale of 64 inches = 1 mile, *viz.*, Háthras, Koil, Sikandra Rao, Atrauli and Kosi, the whole covering an area of about 12 square miles. This party also surveyed for the Public Works Department 1,113 linear miles of first class roads in districts Etah, Agra, Muttra, Aligarh, Bulandshahr, and Meerut on the scale of 64 inches=1 mile. No. 14 Party also traversed 2,113 square miles in districts Allahabad and Fatehpur.

39. In the Central Provinces a number of small scattered areas consisting of excised portions of forest reserves were traversed in districts Saugor, Seoni, Nimár, Chánda, Raipur, Betúl, Bhandára, and Sambalpur, amounting in the aggregate to 619 square miles, also 10 square miles in the town and cantonment of Jubbulpore.

40. In Assam 129 square miles of extensions of cultivated areas, and 145 square miles of tea grants were traversed in districts Kámrúp, Darrang, Nowgong, Sibságar and Lakhimpur, the former to provide data for cadastral survey by local agency.

41. In Madras an area of 131 square miles was traversed and cadastrally surveyed for the Irrigation Department in the vicinity of the Godávari delta.

42. The total areas traversed and cadastrally surveyed during the season are as follows:—

Province.	Traversing square miles.	Cadastral survey, square miles.
Burma	799	680
Bengal	6,884	2,838
United Provinces	2,253	195
Central Provinces	619	...
Assam	274	...
Madras	131	131
TOTAL	10,960	3,844

SPECIAL OPERATIONS.

43. Astronomical observations for latitude have been carried on for many years in India, and have now been completed at 176 stations. In 1901 a theory was advanced by Major Burrard, that the deflections of gravity in India, which had hitherto been attributed to accidental and local attractions, could in reality be classified by regions. This new theory had, as a working hypothesis, the great advantage over the old, that it could be tested by further investigation in the field. From the classification of results made in 1901, it was predicted that a southerly deflection of gravity would be found to exist throughout a great strip of country of unknown breadth, running parallel to the Himalayas from Calcutta to Jodhpur; but that both north and south of this strip gravity would, as a general rule, be discovered to possess a northerly inclination.

With the object of testing the correctness of these predictions, Lieutenant Cowie, R.E., was directed in 1901 to observe several latitudes between Calcutta and Darjeeling, working across the strip of southerly deflection and up to the Himalayas. The results which he obtained were as follows: in the zone immediately south of the strip Lieutenant Tandy had previously found northerly deflections of 3″ and 4″ south of Calcutta: at Calcutta the inclination of gravity was slightly southerly. In the two hundred miles immediately north of Calcutta, Lieutenant Cowie found southerly deflections at four successive stations: the inclination of gravity then changed to northerly, at Jalpaiguri it was 6″ northerly, at Siliguri 23″, at Kurseong 51″.

In 1902-03, Lieutenant Cowie was directed to work again northwards across the strip and to follow the meridian of 78° 30′: the results which he obtained were as follows: in latitude 23° 30′ the direction of gravity was inclined 5″ towards the north: in the next 200 miles Lieutenant Cowie found a southerly deflection at seven successive stations: in latitude 27° 47′ the inclination of gravity began to be slightly northerly; in 29° 16′ its inclination was 12″ northwards. At Birond in the hills, Lieutenant Cowie found a deflection of 44″.

It can therefore now be prophesied with tolerable certainty that on all Himalayan meridians the direction of gravity will be found to follow one general law: in the neighbourhood of the tropic as we move northwards its direction will change from northerly to southerly: it will then remain deflected towards the south for some hundreds of miles, and it will again become northerly, as the Himalayas come into view. The substitution of this regional law for the old theory of local attraction will probably exercise a profound influence on future investigations and programmes.

44. A plate is attached to the report of the Astronomical party on which two sections of the Earth's crust in Upper India have been drawn. The first section shows the actual height of the surface of the ground above sea level, as determined by levelling. The second section shows the actual distribution of matter in the crust, and it indicates what the height of the ground would be if the underlying crust could be brought everywhere to an uniform density.

The profile of the imaginary surface in the second section is practically independent of the density adopted; but when a line, indicating the sea-level, comes to be added to this section, the relative height of this line is governed by the density. If the mean density of the Earth's crust in India had been adopted, the line of sea-level would have been drawn very much lower. But the mean surface density of the whole earth has been utilised, and this being sensibly larger than the density of India, it has raised the sea-level-line.

The second section has been constructed from Captain Basevi's pendulum results in accordance with the formulæ and methods of Professor Helmert, the celebrated geodesist. The weak point in the section is the insufficiency of the number of pendulum stations: it is extremely unlikely that Dehra Dún is the minimum point of the true curve, or that Mussooree is the maximum: Dehra Dún happens to be the minimum discovered by Basevi, and Mussooree happens to be his maximum. Basevi's value for Moré—his only high Himalayan station—cannot be accepted with confidence, as he employed here a light and portable stand, of a class, that has been found by recent experience in Europe to sway with the pendulum itself through an abnormally large arc. A comparison of the two sections illustrates the extent, to which the Himalaya mountains are compensated by their underlying deficiencies of matter; it also shows the relative

excess of matter that lies hidden in the crust to the south of the Ganges valley, and which is doubtless the cause of the southerly deflections that prevail throughout the Calcutta-Jodhpur zone. From this section it is calculated, that a southerly deflection of gravity of 8″ or 10″ must exist at Kaliánpur, the origin of the principal triangulation, and it would follow that the mapping of India has been given always a value of latitude too high by that amount.

GEOGRAPHICAL SURVEYS AND RECONNAISSANCES.

45. Under this head are included surveys and reconnaissances which are executed on the $\frac{1}{2}$-inch and smaller scales. In Sind an area of 2,164 square miles of desert country was surveyed on the $\frac{1}{2}$-inch scale, while a surveyor attached to a shooting party has brought in a reconnaissance survey of 38,000 square miles of Western Tibet. Much work has also been done across the frontier, but the details of the surveys are not available.

46. The question of meeting the constant demands on the Survey Department for survey officers and subordinates for employment on commisions and Military and Political expeditions is a most serious one. The strength of the department, both in officers and native surveyors, is kept at the minimum which will suffice for carrying on the current work in India, no reserve whatever being provided, consequently whenever a call is made to supply surveyors for work outside India, men have to be withdrawn from current work to the great detriment of both efficiency and economy; the point indeed is quickly reached when men cannot possibly be spared. Moreover there are comparatively few native surveyors who are fitted for semi-independent work of this class. A long training in surveying in rough and hilly ground is requisite, and unfortunately there is very little of this class of work now going on in India, the training obtained in a party which is employed in surveying in open cultivated ground being of no use whatever in fitting a man for frontier surveying. The demands for trans-frontier surveys are far more likely to increase than diminish in future, and it seems imperative that a sufficient number of trained officers and men should be kept ready to meet such demands.

HEAD-QUARTERS OFFICES, CALCUTTA.

47. The general direction of these offices remained in the hands of Colonel St. G. C. Gore, C.S.I., R.E., Surveyor-General of India, throughout the year. The Revenue Branch Section was under the superintendence of Lieutenant-Colonel F. B. Longe, R.E., up to 6th October, and thereafter under Colonel J. R. Hobday, I.A.

48. The other offices in Calcutta were, as usual, supervised by three Assistant Surveyor-Generals. Captain E. A. Tandy, R.E., who was specially posted to head-quarters to reorganise the working arrangements of the Mathematical Instrument Office, was transferred to No. 18 Party on the 16th April. Lieutenant C. M. Browne, R.E., has been posted to the head-quarters from 2nd July to assist the Assistant Surveyor-General in charge of the Mathematical Instrument Office. The General and Topographical Branch Sections were under Lieutenant-Colonel F. B. Longe, R.E., up to 11th November; under Captain E. A. Tandy, R.E., up to 23rd November; and under Captain J. M. Burn, R.E., up to the close of the year. The Drawing, Engraving and Map Record and Issue Offices were under Captain Tandy, R.E., up to 17th October, and thereafter Major J. M. Fleming, I.A., returned from leave and resumed charge of these offices. Mr. T. A. Pope supervised the Photo-Litho Office throughout the year. The Mathematical Instrument Office was under Captain E. A. Tandy, R.E., up to 16th March and under Captain J. M. Burn, R.E., up to the close of the year.

49. *Correspondence Office.*—There has been no change in procedure in this office.

50. *Drawing Office.*—The work of the General Section of the Drawing Office has been, as usual, the compilation and revision of the general maps, as well as the addition of any new material to the various standard sheets of which reprints or new editions are required. Besides this a large amount of time is spent in completing for press sheets sent in from the various parties for

publication, and the preparation of any special maps which may be required by Government. Eleven sheets of the North-Eastern Frontier series on the scale ½ inch=1 mile have been completed for press and published, 8 of these being new publications, and the remainder new editions; one other has been brought up to date. Sheet No. 23 of that series on the scale of 1 inch=8 miles has had a large amount of revision work entered upon it, and should soon be published. This sheet has been in hand for years, but having so often had to be laid aside for other urgent cases, work done upon it has been over and over again found superseded before it could be finished off, and portions of it have been done two or three times over. But this is unavoidable as long as it is impossible to keep draftsmen continuously on departmental work. Under the present system draftsmen are liable to be called off their survey maps at any moment in order to take in hand work for other departments, a system which leads to the maximum possibility of mistakes, and the minimum of outturn. Twelve sheets of the South-Eastern Frontier series have been dealt with and of these 7, one being a new publication, have been published.

Of the North-Western Trans-Frontier series 15 sheets on the ½-inch scale have been in hand, and 9 of these have been published. There being no originals extant, it has been decided to redraw and republish the old ½-inch map of Kashmir in standard form, no better material being available of a country, of which maps are so much in demand, and the outline of sheet 44 is almost ready.

Eight sheets of the Andaman Survey on the scale of ½ inch=1 mile have been republished. A large number of names of various localities, tribes, etc., supplied by the Commissioner has been added to these.

The general map of Aden on the scale ½ inch=1 mile has been prepared as a reprint, and published to meet immediate demands. Some additional material from recent surveys having come to hand, this is being added to the existing standard sheet No. 66 N.-W. of the South-West Asia series, from which and the adjoining sheet the above map was prepared. The sheet being in a bad condition must all be redrawn, and fair progress in spite of continual interruptions has been made on this. The map of the Chih-li Province on the scale of 1 inch=8 miles, a compilation from surveys lately done by the China Field Force has also been published.

One hundred and seventy standard sheets on the scale of 1 inch=1 mile have been in hand. Of these 59 have been published, 22 being new publications and 11 new editions. Twenty more are under publication. The above comprise 39 Burma sheets, of which several have been drawn in the office, 88 Central India and Rájputána sheets, 24 Madras, 11 of Bengal, 4 of which are from obsolete surveys being drawn afresh in standard form, 2 Assam, 4 Bombay and 2 Central Provinces sheets. All these maps are being sent to press in modern form under provincial numbers with areas extracted, and completed to margin, where blanks exist, as far as possible from other surveys formerly published separately. The reconciling of these separate surveys, often executed after the lapse of many years, has presented many difficulties, and a certain amount of forcing has been necessary with some, but the advantages to be gained from having all material in a manageable and intelligible form more than compensates for any more or less slight displacements of detail.

The material, obtained from outside sources, added to sheets in the attempt to bring them up to date leaves everything to be desired and is, taken as a whole, utterly undeserving of being included in any professional maps. It may in this connection be interesting to note that from local and Public Works Department sources we have received no less than four different alignments of the railways around Gwalior, and are apparently likely to obtain a fresh one, every additional time we ask for it. From all over India reports come to hand of glaring inaccuracies on our maps, entirely due to the insertion of unreliable material, and this carried on during all the years this system has been in force, must have made many of our sheets quite untrustworthy.

Four sheets of the Madras Forest Survey and 3 Burma Forest sheets on a scale of 4 inches=1 mile have been published. Three more Burma sheets are in hand for reprints.

The Provincial maps of Assam, Bengal, Bombay, Central India Agency, Central Provinces, North-West Frontier Province, Punjab, Rájputána Agency, and Upper Burma have all been in hand during the year. Skeleton and shaded

editions of the Burma map, the maps of the Central Provinces and of the North-West Frontier Province have been published. The Skeleton map of the Punjab is ready, but awaits a final settlement of boundaries, information regarding which is shortly expected from the Foreign Office. Eight of the sheets of the map of Bengal on the scale of 1 inch=8 miles have been brought up to date, but nothing much can be done with such antiquated maps.

The progress on the new 1 inch=32 mile map of India, has not been as satisfactory as was hoped, and some time must yet elapse before even a skeleton edition can be available. Sheet 1 was early in the year made over to the Litho Office, and a proof in outline should be ready before long. The hills are drawn as far as information here is available, but a small amount has yet to be completed, material for which is daily expected from the Frontier drawing office. The remaining sheets are all complete on the stone in outline, but a large amount of correction is necessary on sheet 4, principally due to the receipt of further information from surveys in Yün-nan etc., as well as to the faultiness of names on the old plates from which the transfers were originally taken. The sheet has been thoroughly revised and will go to press soon. The hills are ready for the litho draftsman. A large amount of fresh work has been added to sheet 2, which is now with the Litho Office. Sheets 3, 5, 6 are all far advanced both in hills and outline on the stones and but little correction is required upon them.

The 1 inch=48 mile Railway map, after several unavoidable delays, was published, brought up to 1st June, and is an improvement on the previous edition. The 1 inch=64 mile India has progressed steadily. A large amount of addition and alteration was necessary on sheet 2 to incorporate recent survey material, but the outlines of sheets 1 and 3 should shortly be ready, and the brush-shading for the hills of both sheets is ready for the engravers when they can take it. It has been found necessary to entirely reject sheet 4 of the old map which it was hoped would serve for the duplicate map. A new outline is ready for the engravers, and arrangements will be made to have it finished as soon as the other plates. A new edition of the 1 inch=64 mile district map of India has been prepared and published. Additional information to bring the 1 inch=80 mile and 1 inch=96 mile engraved skeleton maps up to date has been supplied to the engravers. All the general maps are thus now in a fair way to having the latest information upon them, and the coming year should see most of them issued. The skeleton 1 inch=192 mile, prepared for use with foolscap reports, has been completed and the outline for a similar map on the 1 inch=128 mile scale is approaching completion.

Three maps of the $\frac{1}{1,000,000}$ series have been completed, as a provisional edition, during the year, Nos. 78, 83 and 93. Press order has been given for the first two, and the third along with sheets 91, 92, 100, 101 and 102, received from Bangalore, are in proof. Two more sheets, Nos. 85 and 94, are in hand in this office. It is proposed to complete the sheets of this provisional edition which comprise Burma and Yün-nan, before commencing sheets on a revised projection.

Forty-one District maps on the scale of 1 inch=4 miles have been in hand. Of these fourteen have been published, while 19 more are under publication, and proofs are awaited after corrections, etc.

Thirty-nine Administration Report maps on the scale of 1 inch = 8 miles have been dealt with and 12 of these reissued.

The maps of Aden on the scale of 8 inches = 1 mile, the map of Aden Cantonment and the map of Steamer Point Cantonment, both on a scale of 24 inches = 1 mile have been brought up to date from information supplied by the Military Works. Plans of Lebong, and Mysore and environs, have been brought up to date and published, as also a map of Hsi Paw town in six sheets. Sheet No. 6 of the 16 inch = 1 mile map of Calcutta has been revised and sent to the engravers, and sheets 2 and 5 are in hand. Of the sheets of the Calcutta Survey on the scale of 50 feet equal one inch, 5 sheets have been sent to press for second editions, and 26 more are in hand for additions.

Besides the above a large amount of miscellaneous work has been done in the matter of index maps, type and map specimens, etc.

On 115 sheets of the Atlas of India corrections or additions have been made, and as these are mostly from extra departmental sources their accuracy

is doubtful. On 45 other plates additional work has been prepared for the engravers from survey sheets. On 13 sheets brush-shading has been carried out for the engraving of the hills.

Two of the new Degree sheets of Burma on the scale of 1 inch = 4 mile which are intended to take the place of Atlas sheets until these can be engraved (Nos. 52 and 53) have been sent in for publication and are passing through the press. They should form very useful and satisfactory maps.

The staff available has been quite unable to keep pace with the demand for reprints of sheets out of stock, and arrears are great and increasing. Sheets would be sent as they are, uncorrected, if the press could take them in hand.

As usual the demands for extra departmental work have been continuous, and until a separate staff can be arranged for this work, it can only result in delay and unsatisfactory work all round, when men have to be continually shifted from job to job. Early in the year the office had to undertake the preparation of a general map of India to illustrate the report of the Irrigation Commission. As no existing map would meet requirements, a new edition of the 64-mile District map had to be set in hand, and pushed forward with all speed, necessitating the removal of draftsmen from their tasks in hand, until the outline, hills and copies for colour plates had been completed. Twenty-one maps for Dr. Grierson's Linguistic Survey have been dealt with, either for preparation or examination in the proof stage, and as these are all intended for publication in several colours they involved much work. There has been the usual work in bringing up the various Provincial Administration Report maps, almost invariably asked for at the last moment, and expected at once. A series of four maps intended for the India Office Decennial Report on the Moral and Material Progress of India, to illustrate the progress of Railways and Canals, as well as the areas affected by famine was also pushed through at high pressure. Besides the above many other minor maps for the Civil, Foreign, Public Works Department, and Military Department, besides a series of manœuvre maps, etc., for the Military authorities have all been prepared for press. The Postal map of Bihár drawn on the scale of 1 inch = 4 miles has been completed and published on half that scale. A similar Postal map of Bengal has been drawn on the same scale, and is now at press for reduction while the drawing of the Postal map of the Central Provinces is practically completed. All the above are being drawn on trace prints of Atlas sheets, the Postal information being supplied by the Postal authorities, and are component parts of a general Postal Atlas of India.

The preparation of the New Gazetteer of India has thrown a large amount of work on this office for which we are most inadequately provided with staff. From every part of India have come incessant and urgent demands to be supplied with information as to the geographical positions of long lists of names of places, lengths of rivers, etc., etc., and as many of these involved much searching, it has all hindered the work of the Examining section enormously, and the sheets passed number 2,504.

All through the year there has been much sickness among the staff, and the inevitable lack of supervision has caused many mistakes and delays which with better fortune might have been avoided. In a climate such as this the strength sanctioned should allow a margin for sickness and leave.

51. In the Revenue Section 204 standard sheets have been dealt with. Of these 79 are new publications, 50 of which in 103 sections are new receipts from the parties, 49 are new editions, or old sheets again published in modern form, and 75 are reprints. On these last, however, there has been much work in the shape of extraction of areas, not formerly given, rearrangement of notes, etc. Of the above, 106 have been published, and 32 are passing through the press. The new sheets received in the office are from recent surveys in Bengal, Burma (7 of which are mere fragments), Central Provinces, United Provinces and the Punjab. An effort has been made when possible to complete all sheets to margin, and 40 have been thus prepared. The work of attempting to join up into standard form the fragmentary sheets of Bengal has been steadily prosecuted, and 31 have been in hand, 7 of which are now passing through the press. The compilation of these has presented many difficulties, some being based on spherical values, while others are entirely on rectangular ones, even Great Trigonometrical stations within the circuits being plotted from traverse values! Wherever possible the initial point of circuits has been converted to a spherical

value, all Great Trigonometrical stations have been plotted from spherical co-ordinates and the intervening detail gradually forced in when necessary between these points, a note to this effect being placed on all sheets thus treated. They can at best be but makeshift maps, though infinitely better than what they supersede, and will afford much relief in the Issue Office. Any sheets or portions thereof (chiefly district maps) which could be reproduced, after touching up, by photography have been so treated, the remainder being either entirely or in part redrawn.

A new edition of the 6 inches = 1 mile map of Calcutta has been published, and the 3-inch one is being similarly revised, and should shortly go to press.

The three special maps illustrating the Nepal boundary along the Sárda river, having been declared faulty, the old traverses have been recomputed, convergency corrections applied and connections made with Great Trigonometrical stations lying near, while they have been linked on to more recent traverse work along the boundary. The values for the pillars thus obtained should admit of their being easily placed on any map. The three sheets have all been redrawn for publication in two colours, and proofs are now with the Foreign Office for final orders.

The usual revision work has been carried out on Index maps and two new ones prepared. Eight hundred and fifteen pages of traverse records have been copied and examined in response to applications, while much miscellaneous computation work, calculation of areas, etc., has been completed. The final examination of the traverse records of Chhindwára district has been in hand and has been almost completed.

Eighty traces and copies of village plans have been prepared for district officials, while 1,203 applications from private parties for copies of original records have been received. In response to these appeals 2,154 authenticated copies have been supplied, the Government fees thereon amounting to R1,206.

Coloured copies of maps for issue to a number of 21,786 have been examined and passed and in addition 771 pairs of office copies have been prepared and passed, while 718 more have been corrected or added to. These are now getting into somewhat better order, and the register of them now kept up should prevent their being lost or mislaid amid the various sections of the office.

The publication of the few remaining cadastral sheets, 2,548 in number, was completed by the end of March, 858 of these having been reproduced by the Vandyke process.

52. *Engraving Office.*—The amount of engraving work turned out by this office is much the same as last year. Three new quarter sheets of the Atlas of India Nos. 24 S. E., 79 N. E. and 178 N. W. have been published, as also a map of the Central India Agency with hills on the scale of 1 inch=80 miles, and the new outline map of India for reports on a scale of 1 inch = 192 miles has been completed. A large number of sheets of the edition of the 1 inch=64 mile India issued in 1902 has had to be reprinted, the paper having been found to be damp spoiled when coloured. A new edition of the skeleton 1 inch=128 mile India has been issued, and prints from the Central Province map and from 54 other sheets corrected to date have been supplied to the Map Record and Issue Office in full compliance with indents, while numerous pressing demands have been met by small supplies of 122 sheets.

Work on the proposed 1 inch=32 mile map of India has been carried on as opportunity offered. Matrices have been obtained of four of the plates, and a considerable amount of correction done upon these, while one of them has been sent for a duplicate. Sheet 12 has been reengraved in outline. Most of the other general maps of India have been in hand. Much work has been cut on plates one and two of the duplicate 1 inch=64 mile India, and the former plate is nearly ready to commence the hill engraving upon: the old map has also been in hand for correction. Much work has been done on the plates of the 1 inch=80 and 1 inch=96 mile maps. Besides internal corrections a large amount of revised survey is being cut on both frontiers. Both the hill and outline plates of the 1 inch=128 mile map have been corrected, and the projection for a new skeleton map on this scale has been cut upon a plate, and a print sent for compilation. Corrections have also been made on the two plates of the 256-mile India.

The 1 inch=16 mile map of Assam has had much additional work cut upon it, necessitated by the expansion of the Province. The Central Province

map has been again corrected and added to, while the outline and writing of the Mysore portion of the 1 inch=16 mile Madras has been almost completed, and this outline map in six sheets should shortly be available for issue. The 1 inch=16 mile map of the Punjab has been off and on in hand for corrections, and is awaiting what it is hoped will be final information regarding frontier boundaries, which is daily expected from the Foreign Office. Should this not entail large alterations, the map is practically ready for publication.

The outline of the 1 inch=32 mile map of the Punjab has also been revised and completed, but the writing still remains to be finished.

Five provincial and 31 district maps, for administration reports have had work done upon them. The plates of the map of Calcutta on the scale of 16 inches=1 mile have been taken in hand for revision, and a considerable amount of work has been done on plates 3 and 6.

Good progress has been made with the plates of the new map of Calcutta on the scale of 6 inches=1 mile, and the cutting of the street names is now in hand. Two charts, two index maps, eighty quarter Atlas sheets in various stages of progress have been added to, ninety-two published quarter sheets have been corrected in order to keep them up to date from information furnished by the Drawing Office, which must often be far from reliable. Thirty-three new quarter sheets have been projected, and new borders and graticule figures cut. Twenty-four of the old pattern full plates have also been corrected, while 103 miscellaneous plates of scales, tints, map headings, heliogravure plates, including the certificate for exhibitors at the Delhi Art Exhibition, etc., have been worked upon during the year.

It has been decided to restrict the issue of the full Atlas sheets as much as possible, and in cases when two or more of the quarters of any sheet have been published, the remaining quarters will be in future published from stones prepared from transfers from the old full plates, until such time as engraved plates are available. Sixteen of these quarter sheets will be thus prepared, and transfers for seven of these have been supplied to the Litho Office where the borders, footnotes, etc., will be added. Besides the above, transfers from ten quarter plates, which for lack of printing power could not be taken up, have been supplied to the Litho Office, and prints from the stone of all of these have been obtained. Though small supplies of sheets urgently wanted have from time to time been made to tide over pressing demands arrears are great, and 109 sheets are still entirely out of stock, while 121 more are practically so.

The new room for the copper plate printing section has been completed, and the additional space gained by alterations has allowed of a rearrangement of the presses in the old room. An additional press, which formerly could be little used, has of late been in constant work, and the outturn of the section has been 31,472 prints, an increase of 5,418 pulls on last year's returns. The cases containing the three new presses, one of which will be worked by an electric motor, have arrived, and these will be got into working order as soon as possible.

Two hundred and seventy-one plates were steel faced, and 52 plates have had surface corrections filled in by electro deposition. As far as this method of obtaining a new surface to work upon is concerned, the process continues to give satisfaction, but it has been found latterly on several occasions, that prints obtained from plates which have been frequently subjected to the process are not as clean as they should be. The silver deposit made on the plate prior to immersion in the bath appears in time to affect the surface of the plate, making it take up ink, and the necessary burnishing to remove these slight inequalities is far from good for the engraved detail. But it is hoped that this difficulty may be surmounted shortly.

53. *Photographic and Lithographic Office.*—The outturn of this office, as measured by the number of copies of maps, plans and other subjects printed in the lithographic machines and presses, is again very large. For the third year in succession the number of copies printed, coloured and uncoloured exceeded one million, the actual figures being 1,032,495, or 131,634 less than the record outturn of last year. Of these, 312,812 were copies of maps printed for the Survey of India, the balance of 719,638 copies being printed for other departments and officials. In no previous year has the proportion of departmental work done been so small. The large excess of work done for other departments

is chiefly due to the demands made on the office during the first three months of the year for work in connection with the Delhi Durbar and the manœuvres at Delhi and in other parts of India carried out last cold season. This work occupied the whole printing power of the office during October and November 1902, to the exclusion of all departmental work. The defect in the amount of the latter class of work is also in part attributable to the small amount of cadastral work received for reproduction. The heavy arrears of Burma cadastral mapping had all been worked off in the preceding year, when an extra establishment was sanctioned for the purpose, and the cadastral work of the year under review was confined to the current outturn of No. 7 Party in Burma, amounting to 3,870 sheets received, as compared with 13,115 received last year.

In the other sections the amount of work executed is also highly satisfactory. The type-printing section, owing to heavy demands for departmental forms, established a record with over two million pulls and one million copies—a result obtained without any increase of establishment, and only by working at high pressure throughout the year. The silver-printing section yielded a considerably larger outturn both of silver-prints and cyanotype prints. In the heliogravure section the outturn of copies printed from photogravure plates was less than last year, though the number of plates prepared was considerably larger.

54. The disproportionate amount of work executed in this office for other departments, as shewn by the above figures, is a matter which requires serious attention. And not only is it the case that the *quantity* of work done for the Survey Department suffers from the heavy demands made from outside, but, what is even more important, the *quality* suffers also, owing to the fact that so large a proportion of the outside work has to be done by litho draftsmen, such work not being usually of a kind that can be executed by photozincography. The result is that, of the total strength of the drawing section, two thirds are constantly engaged on extraneous work, thus rendering it impossible to employ the section to anything like the proper extent in reproducing the maps of the department by lithography. It is unfortunately also the case that the quality of much of the work executed by photography is not as good as it should be. This is due in part to circumstances over which the reproducing office has no control, but in a larger measure to the fact that the skilled European element in the office has been allowed to fall much below its due strength. There are now only four posts reserved for assistants trained in England, and only one of these exercises supervision over the photozincographic work; whereas when this branch of the work was first started no less than five European assistants were brought out to supervise it. These men have all retired, and their places, with one exception, have been taken by Eurasians trained in the office. The ever-increasing quantity of work which the office is called upon to undertake has of course rendered increases to the native subordinate staff necessary from time to time, and these have been made from savings effected by the retirement of the senior European assistants. The result is that, while much more work is now done at a considerably reduced cost in labour, this has been effected at the expense of quality. The manner in which these defects can best be remedied is now occupying the attention of the Government of India, and it is to be hoped that no expense will be spared to place this office on a footing which will enable it to carry out in an efficient manner the important work it has to perform.

55. The following are the principal items of work executed in the Lithographic Branch of the office during the year:—The drawing of the new 32-mile map of India was continued throughout the year, new material being added to the stones as fast as it was received from the Drawing Office. The sheets in hand were Nos. 1 and 4 for outline and Nos. 3 and 6 for hills. No. 1 contains much heavy work and will take about four months longer to complete. The hill stone of No. 6 was completed and a proof in outline and hills sent to the Drawing Office in March 1903. The hill stone of No. 3 will be finished by the end of December 1903. The remaining departmental work done in this branch includes (1) a map of the Punjab and Kashmir, on the 16-mile scale, with hills in brown, lithographed from a copper-plate transfer. A proof of one of the sheets has been submitted and the other should be ready in November 1903. (2) A map of the North-West Frontier Province, on the 16-mile scale, in one sheet, lithographed from a copper-plate transfer. (3) Fifty-four district maps,

also from copper-plate transfers, of which 10 were printed off, proofs of 18 more were submitted, and the remaining 26 were still in hand at the close of the year.

56. The work done by lithography for other departments included (1) the completion of the drawing of one more sheet of the Telegraph map of India, on the 32-mile scale, and much work done to the remaining three sheets, which ought to be completed in about two months' time. (2) The Railway Mail Service map of India, on the 32-mile scale, was printed from stone in black and eleven colours and despatched in February 1903. (3) The six sheets of the new Military map of India, on the 32-mile scale, with the military information shewn in red, were put in hand and completed during the year, and proofs submitted. (4) A 16-mile map of the Punjab and Kashmir, in two sheets, was lithographed from a copper-plate transfer for the Punjab Government, of which one sheet was completed and the other should be ready by December 1903. (5) Five maps were lithographed and printed in colours for the Census Commissioner's report. The six census maps mentioned in last year's report were printed off, as well as two maps prepared for the Linguistic Survey but also published in the Census Commissioner's report. (6) Thirteen maps, each in numerous colours, were lithographed for Dr. Grierson's Linguistic Survey, and proofs submitted, of which six have been returned with press order and one has been printed off. Besides the above a large variety of miscellaneous work has been lithographed for different extra-departmental purposes, including 31 maps and sketches for the Foreign Department.

57. In the Photographic Branch the most important departmental publications of the year included a new edition of the 48-mile Railway map of India, in four sheets, with hills in brown, photozincographed and 400 copies supplied; and a map of India shewing district boundaries, on the 64-mile scale, in two sheets, photozincographed and 300 copies supplied. Three hundred and eight standard sheets of the Topographical and Revenue Surveys, on various scales, were either photozincographed or reprinted from old plates, of which 48 were in two colours. In addition to the number of standard sheets printed for departmental purposes, 31 sheets of the Central India and Rájputána Survey were printed for the Director of Land Records, Gwalior State, and 5,600 copies supplied on cloth.

58. A very large amount of photozincographic work was executed for other departments, of which the following items are the most important:—(1) An Irrigation map of India, on the 64-mile scale, in two sheets and in six colours, was prepared for the report of the Irrigation Commission, and 3,900 copies were supplied. (2) For the same report a map showing the principal canal systems in Bengal, on the 8-mile scale, was prepared and 4,050 copies were printed. (3) Two skeleton maps of India, on the 128-mile scale, illustrating progress of railways and irrigation respectively, were prepared for the Secretary of State for India, and 900 copies of each were printed, in two colours. (4) Two maps of Chinese Turkestán were prepared for Dr. M. A. Stein and 100 copies of each printed, in eight colours. (5) A Postal map of Bihár, in two sheets, was prepared for the Post Master General, Bihár, and 135 copies printed. (6) For Dr. Grierson's Linguistic Survey seven maps in various colours were prepared, and 9,240 copies supplied. (7) A very large number of manœuvre maps, on various scales, and chiefly in two colours, were photozincographed and supplied to the Military authorities. For the Delhi manœuvres alone three maps were prepared and over 5,000 copies printed. (8) For the Delhi Durbar a number of miscellaneous maps and plans were reproduced (including 29 plates of music for the massed bands) and 30,238 copies were supplied to various officials connected with the Durbar, and for stock in the Map Record and Issue Office.

59. The substitution of the Vandyke process for photozincography, as a cheaper and more expeditious method of reproducing the cadastral work of the department, enabled a reduction of the cadastral staff to be made during the year. A scheme was submitted to Government and received their sanction, which involved the abolition of several cadastral posts, including one on ₹200 in the second division. Advantage was taken of the saving thus effected to add four new posts to the Litho Drawing section, which, as pointed out in paragraph 61 of last year's Report, was considerably undermanned, and four new posts were also added at the bottom of the fourth division to provide the

means of training a better class of men as machine printers. Provision was also made for the Direct Zinc-printing section, to work the Vandyke process, this section having originally been organised for the reproduction of Bengal cadastral maps, and maintained by a special grant from that Government who are now carrying on the work with an establishment of their own. These changes, which have resulted in a small monthly saving, and added greatly to the efficiency of the office, are due to the inventive skill of Sub-Conductor F. R. Vandyke, R.E., Foreman Litho-Printer, the patentee of the process which bears his name.

60. The proposal referred to in paragraph 62 of last year's report for the substitution of electric power for steam for driving the printing and other machinery was carried into effect at the close of the year, with the sanction of the Government of India. At the end of September 1903 the motors had been installed, and the changes gave promise of being entirely successful. Further report on the subject will be made next year.

61. *Map Record and Issue Office.*—The demands upon the Map Record and Issue Office have as usual been incessant, and with difficulty coped with, and delays in the supply of maps, etc., are still far too frequent.

62. One hundred and seventy-six thousand seven hundred and forty-four sheets of an aggregate value of R1,85,938 were issued during the year. Of this sum R12,487 were realized from private sales. The falling-off in both numbers and value is due to the cessation in the supply of cadastral sheets, 71,385 of these having been despatched this year, as against 166,780 during 1901-02. No further despatches of these maps will be made by this office, but as they were always forwarded in large consignments their absence does not materially lighten the daily work. The number of new maps received for publication was 105. In addition 7,239 original maps, volumes of records, etc., were issued from store to other branches of the department, and 6,303 were received back again.

63. The work of transferring the original cadastral sheets from this office to the head-quarters of the various Local Governments or districts, has been carried on throughout the year, and the sheets of fourteen districts in Burma, and one in Assam, a total of 26,799 sheets, have been despatched from the office during the year. Others are partly invoiced and ready, and will be sent gradually as opportunity offers. The Governments of Burma, Central Provinces, United Provinces, and Assam have intimated that they can now receive the sheets if sent. The sheets of Burma and Assam will be stored at district head-quarters while those of the remaining two will be kept at provincial centres, as will also those of Bengal. A commencement has also been made with the transfer of the stock of large scale forest maps to Dehra, where they will be stored and issued under the orders of the Superintendent, Forest Surveys. Despatches of 896 copies of 20 maps, besides 538 original plane-table sections, have been made, and a further consignment is ready as soon as an intimation comes to hand that they can be housed.

64. Work on the catalogues has been carried on and fair progress has been made. The catalogue of Burma has been issued, while those of the Atlas of India, Bengal, Punjab, United Provinces and of the general maps of India and adjacent countries are all in the proof stage, and the first three should shortly be finally passed for press.

65. The task of rearranging and reconstructing the map storage space has been steadily prosecuted. All the racks in the east wing have now been moved from the walls—a most laborious task—but it is hoped the ravages of white ants, which were continually ruining the stock, may be now easily detected. By slight rearrangement 380 new shelves have been provided among existing racks, which will give ample space for many years to come for the Burma and Sind sheets, which required more room. For the Administration Report maps 33 new shelves have been added. Much work has been done in rearranging the maps and bringing all connected together, as owing to the filling up of allotted space, sheets of Provinces had perforce been placed apart.

66. Though 652 special maps have been opened out and re-stored flat, work on these has been in abeyance during most of this past year. The new racks built for these maps have all been filled up, and as the despatch of the forest sheets will shortly provide ample space, it is not necessary to build more. When our existing sheets have been rearranged and fragmentary main circuit

and district maps replaced by standard sheets, there should be ample space for all maps that can be reasonably expected for many years to come. For efficient working, our sheets must be standardized, and only delay and disappointment even with overtime working, can be expected when the staff has to deal with the meaningless fragments which constitute a large part of our present stock. It will be necessary to examine our stock of both original and printed maps, as much of the latter might be destroyed without loss to any one, and among the former there are many antiquated maps which are utterly useless to us and are decaying away unseen when they may possibly have some antiquarian value. An attempt is being made to have them placed by themselves, but current work prevents much time being spared for this additional labour, and of late it has had to be dropped entirely. It is to be regretted that the staff is still not sufficient for efficient working. There are invariably men absent from sickness, etc., and consequently arrears accumulate. The recent most necessary order regarding the entry on the invoices of all register numbers of maps has much increased the work of the despatching section, and arrangements must be made to augment it from elsewhere.

67. Although a great deal still remains to be done in this office, the improvement in its state which has been brought about during the last few years is enormous. By careful rearrangement a large amount of rack room has been made available, maps previously stowed away in rolls in inaccessible spots have been opened out, listed and racked, valuable original fair maps hitherto put away folded up for want of space have been properly arranged in reconstructed almirahs and the whole storage arrangements greatly improved.

These reforms are entirely due to the Assistant Surveyor-General, Major Fleming who, despite having to work with a staff insufficient even for its ordinary routine duties, has by his untiring energy and zeal succeeded in effecting this transformation. He has been ably assisted by the staff of the office, especially by Mr. Rundlett, the map curator. There is still further room for improvement, but unless speedy relief is given to this office by transferring the issue of provincial maps to local centres it will be necessasy to increase its staff.

68. *Mathematical Instrument Office.*—Piecework which was introduced last year has been gradually extended and the number of men employed on it at the end of the year under report was 85, while the number still on daily labour was 170. This system of working has proved most satisfactory and the figures below show that it has led to a large increase in the amount and value of the work done.

69. A net saving of ₹9,500 was effected on the year's budget.

70. The book value of the serviceable stores in hand at the end of each of the last three years ending 31st March 1903 was ₹5,36,053, ₹5,13,547 and ₹4,72,065, respectively. This gradual decrease is due to a considerable extent to the economy which has been effected by submitting our indents for instruments from England piecemeal as the necessity for any particular article arises or is foreseen instead of, as in former years, submitting only one large annual indent which often led to certain classes of instruments accumulating in great numbers owing to a change in the type of article required or a sudden cessation in the demand. There have, however, been heavy demands from the various Government Departments for the more valuable instruments such as theodolites and levels, which take a considerable time to manufacture and the stock of these is getting somewhat dangerously low.

71. The book value of the repairable instruments in store at the end of each of the same three years was ₹2,41,211, ₹2,30,155 and ₹1,81,000 and the value of instruments and stores purchased locally during these years was ₹36,024, ₹17,793 and ₹13,328. Thus we have a steady and satisfactory decrease under both these headings.

72. These reductions have been effected by the increased efficiency of the workshops, the cost of which has increased but not nearly to the same extent.

The workshop expenditure on labour and materials for the three years under comparison was ₹42,823, ₹54,180 and ₹60,700, respectively, while the value of the work done in the corresponding years was ₹98,283, ₹1,11,344 and ₹1,24,125. Therefore taking the first year which was the last under the old system as our starting point, we find that we have spent in the two years during which the new system has been gradually introduced ₹29,234 more than we

should have done perhaps under the old system but have raised the value of our work by R38,903, and to this must be added a very large proportion of the amount saved under local purchases which, as will be seen from the last paragraph, amounts in the two years to R40,927, the instruments now being made in our shops being mostly those which were formerly purchased locally.

73. The number of instruments issued during the year was 76,334 as against 73,903 in the previous year, their corresponding values being R3,22,657 and R2,84,719, while the number brought into the issue store from all sources for the same years was 80,116 and 71,831, their values being R2,79,587 and R2,68,426, of these 29,398 and 29,593, valued at R47,729 and R33,427, respectively were manufactured in the workshops.

74. The number and value of instruments returned to store finally by public officers has decreased but more have been sent for repairs and reissue.

75. The value of instruments obtained from the Director General of Stores was £4,820 and of materials for manufacture £1,584. This total is about the same as in the previous year. The average value for the past 11 years is £6,753 but nothing definite can be laid down on this account as the demand for theodolites, levels and other expensive instruments obtained from this source varies very much and is more or less dependent on Famine Works, Railway and Irrigation extensions and other similar undertakings.

76. The profit and loss statement for the workshop shows a profit of R15,865 while last year there was a loss of R1,308. This tends to prove the value of the piecework system and is more than six times as great as the average profit of the last ten years. Considerable improvements have been effected in the arrangements of the shops facilitating the supervision and concentrating the workmen employed on certain classes of instruments, such as theodolites, in certain rooms, etc. Good progress has been made in the erection of the new testing and adjusting building and much attention has been given to the more systematic arrangement of the stores generally. The reorganisation, both in the system of working and in the arrangement of the stores, machines, etc., has had to be carried out with as little dislocation to the regular work of the offices as possible and the results on the whole are very satisfactory.

BRANCH OFFICES.

77. The superintendence of the Trigonometrical Branch was in the hands of Mr. J. Eccles, M.A., throughout the year, and Mr. C. H. McA'Fee held charge of the technical offices.

During the year the following papers were printed and issued :—

1. On the Projection for a Map of India and Adjacent Countries on the scale of 1 : 1,000,000 by Colonel St. G. C. Gore, R.E. (second edition).
2. Spirit Levelled Heights No. 10 Madras Presidency, Central Provinces, Central India Agency and the United Provinces of Agra and Oudh.
3. Spirit Levelled Heights No. 1 Assam.
4. Spirit Levelled Heights—Bengal and Assam ; and the following were printed for the use of the department :—.
5. Notes on Triangulation by Colonel St. G. C. Gore, R.E..
6. Notes on the Theory of Error of Observations by Mr. J. Eccles, M.A.
7. On the Projection used for the General Map of India.

As the first issue of 150 copies of Professional Paper No. 5 "The Attraction of the Himalaya Mountains on the plumb line in India" had been exhausted, a reprint was put in hand and will be ready for issue early in 1904.

The Computing section had so many calls for data that very little could be done to the regular work. The greater portion of the computations of the secondary triangulation in Kumaun and Garhwál was however revised for incorporation with the N. E. Longitudinal series, and a beginning was made on the press copy of the second edition of the Great Arc series, section 18° to 24° after the completion of the correction of the computations. Data was supplied to 46 officers, Captain C. G. W. Hunter's Astronomical observations in China were computed for the Quarter Master General and Lieutenant A. A. Crookshank's

triangulation in Southern Persia was computed and adjusted and the data supplied to the North-West Frontier drawing office. The examination and comparison of press proofs is a heavy item in the routine of this section and it often happens that all the computers are employed as proof readers and correctors. Besides the proofs of all the pamphlets published in this office which were examined by this section, the proofs of the Professional Papers published in Calcutta were sent here for comparison and examination.

In the Drawing section the District Map of Kángra was completed and sent to press and a "Map of the Ssŭ-Ch'uan Province of China, showing the routes of Lieut-Colonel C. C. Manifold, I.M.S., and Captain C. G. W. Hunter, R. E.," is being prepared for the Quarter Master General; sheet No. 7 N. W. of the N. E. Trans-Frontier series was corrected up to date and a second edition issued and 43 plates for Professional Paper No. 7 were drawn and zincographed. As the Settlement Commissioner, Central Provinces, required plots of the Hoshangabad district and forest boundaries, on the scale of 16 inches to a mile, this section had to take up the work. The plotting was done principally by contract but the examination of 254 sheets of plots of traverse line with details, employed three draftsmen for 10 months.

During the year under report 889 maps and diagrams were photozincographed against 618 in 1900-1901 and 1,002 in 1901-1902. Most of the arrears have been worked off and as the Superintendent, Forest Surveys, has reduced the number of copies of the forest sheets required by 40 per cent. it is hoped that the work will continue well up to date.

The compilation of the Professional Volume giving the results of the Spirit Levelling in India, has made fair progress. During the year 37 of the 118 lines of levels have been tabulated. Some of these had to be recomputed owing to connections having been made to tidal stations started subsequent to the levelling.

A topographical survey of the Native State of Tehri-Garhwál, as a training ground in topographical work for young officers of the Imperial and Provincial Branches of the Survey of India, having been sanctioned under Revenue and Agricultural Department letter No. 1067 of the 7th July 1902, Lieutenant R. H. Thomas, R.E., and Lieutenant L. C. Thuillier, I.A., were posted to the detachment and started the triangulation on the 20th November 1902, the former in sheet 228 and the latter in sheet 229 and 230 of the standard sheets of the United Provinces of Agra and Oudh. During the months of May and June the dust haze retarded the work and an outbreak of cholera in Lieutenant Thuillier's camp in April necessitated his closing work for three weeks until the epidemic abated. The field work closed on the 15th June 1903, by which time Lieutenant Thomas had completed the triangulation of 513 square miles and Lieutenant Thuillier had partially completed 361 square miles. As both these officers were posted to field parties early in the recess they were not able to complete the computations of their work, and hence the resulting errors could not be tabulated.

One officer of the Imperial Service, Lieutenant C. M. Browne, R.E., went through a practical course of trigonometrical, topographical and astronomical work, and nine sub-assistant superintendents of the Provincial Service were put through a course of a topographical surveying, levelling and mapping.

A sub-surveyor who accompanied a shooting party, has succeeded in surveying 38,000 square miles, making a valuable addition to the geography of western Tibet.

Six levelling staves, made by the Mathematical Instrument Office after the design of officer in charge No. 25 Party, were compared against the Standard foot with micrometers G and H of the base line equipment. Each staff is graduated on both faces, one the plain face being graduated in centesimal divisions of 12 inches and the other the red face in centesimal divisions of 12·5 inches. The first pair received in December 1902 and now marked 00 and 04 showed that the red faces were extremely well graduated, each division averaging 0·12500088 inches but the divisions on the plain faces were not so satisfactory. The result of the comparisons was reported to the Assistant Surveyor-General, Mathematical Instrument Office, and the defect was remedied in the two pairs received in September 1903, as the comparisons of both faces of Staves 01, 02, 03 and 05 show that the graduation has been

very carefully made. Opportunity was also taken to examine the divisions on Troughton and Simms Steel Bar No. 1 received in September 1900.

78. The new office for the Superintendent, Trigonometrical Surveys, the construction of which was sanctioned by Government, was completed and occupied during the year.

It is a compact two-storied building containing convenient accommodation for the Superintendent and the clerical establishment of his office and for the officer in charge of the Computing Office, as well as two rooms for attached officers. There is also an excellent library room.

79. The offices of the Forest Surveys, Bengal Presidency, were under the superintendence of Major P. J. Gordon throughout the year and were employed as usual on correspondence and accounts, computations, area statements, the mapping of field surveys, the compilation of special working plans and other maps, the distribution of published maps and the up-keep of the map records of the Forest Department. During the year 269 maps have been sent to press and 350 have been published. On the 30th September over 450 maps were in different stages of progress and 83 were in the press. 10,117 printed maps have been distributed, of which 7,205 were coloured and 3,795 were mounted in book form.

80. The new office which was sanctioned by Government as a Head-Quarter office for the Forest Survey Branch was commenced in November 1902 and completed in the following May. The office is a large one-storeyed fire-proof building with out-houses for storing instruments, tents, etc., and is conveniently situated in the compound of the Great Trigonometrical Survey Offices. It has been specially designed as a Drawing and Map Record Office and has proved most convenient and suitable for the purpose.

Considerable numbers of original records and printed maps have already been transferred to it from Calcutta and it is hoped that by the end of the year all forest maps will be stored at Dehra Dún.

81. *North-West Frontier drawing office.*—This office has as usual been employed on the preparation of maps of the Northern and North-Western Trans-Frontier series, together with a map of the Province of Kiangsu in China, prepared under the direction of the Surveyor-General of India for the Intelligence Branch of the Quarter Master General's Department.

The following sheets were sent to press and subject to slight corrections by the Quarter Master General's Department will shortly be published:—

Northern Trans-Frontier series, sheet No. 2 S. W., scale 1 inch=4 miles. *North-Western Trans-Frontier series*, sheet No. 333, scale 1 inch=2 miles; No. 15 N. W. (2nd edition), No. 15 S. W. (2nd edition), No. 15 N. E. (5th edition), No. 15 S. E. (3rd edition), scale 1 inch=4 miles. *China Survey*, map of the Province of Kiangsu, scale $\frac{1}{1,000,000}$. *General Map*, India sheet No. 1, scale 1 inch=32 miles.

A list of maps is in course of preparation showing the number of sheets of the $\frac{1}{2}$, $\frac{1}{4}$, and $\frac{1}{8}$-inch scales of the Northern and North-Western Trans-Frontier series and those of the South West Asia series that require either new editions or corrections to bring them up to date. The present staff of this office is not sufficiently strong to cope with its current work, and if any attempt is to be made to revise and keep up to date the older editions of the maps, a considerable increase to its strength will be necessary.

LOCAL DRAWING OFFICE.

82. These continued the compilation of one inch topographical maps from cadastral surveys. Such maps are published as preliminary editions, and require supplementary survey in the field before they fulfil the requirements of military topographical maps.

83. One such drawing office is located at Naini Tal in the United Provinces, one in Bengal at Calcutta and a third in Assam at Shillong. The progress made in the mapping in these offices is to be found in Part II.

There still remains a large amount of arrears of this mapping, to cope with which the drawing establishments have been increased.

84. The drawing offices for the compilation of geographical maps of the frontiers of India and Burma were employed as usual at Mussooree and Bangalore.

ESTABLISHMENT.

85. The department has lost the services of one officer of the Imperial Service during the year.

Lieutenant F. B. Tillard, R.E., Assistant Superintendent, 2nd gradè, died at Mussooree on the 2nd May 1903. He joined the Survey of India on the 11th April 1901 and during the short period he was found to be a most able and promising officer, and his untimely death is a great loss to the department.

86. In the Provincial Service the department has lost the services of nine officers during the year, *viz.*, by the retirement of Messrs. H. Todd, E. J. Connor, T. H. Rendell, G. Campbell, W. A. Fielding, and Ahmed Ali Khán, Khán Bahádur; and by the death of Mr. J. Keating. Mr. H. R. Hunter resigned his appointment and Probationary Sub-Assistant Superintendent Abdus Sami was discharged.

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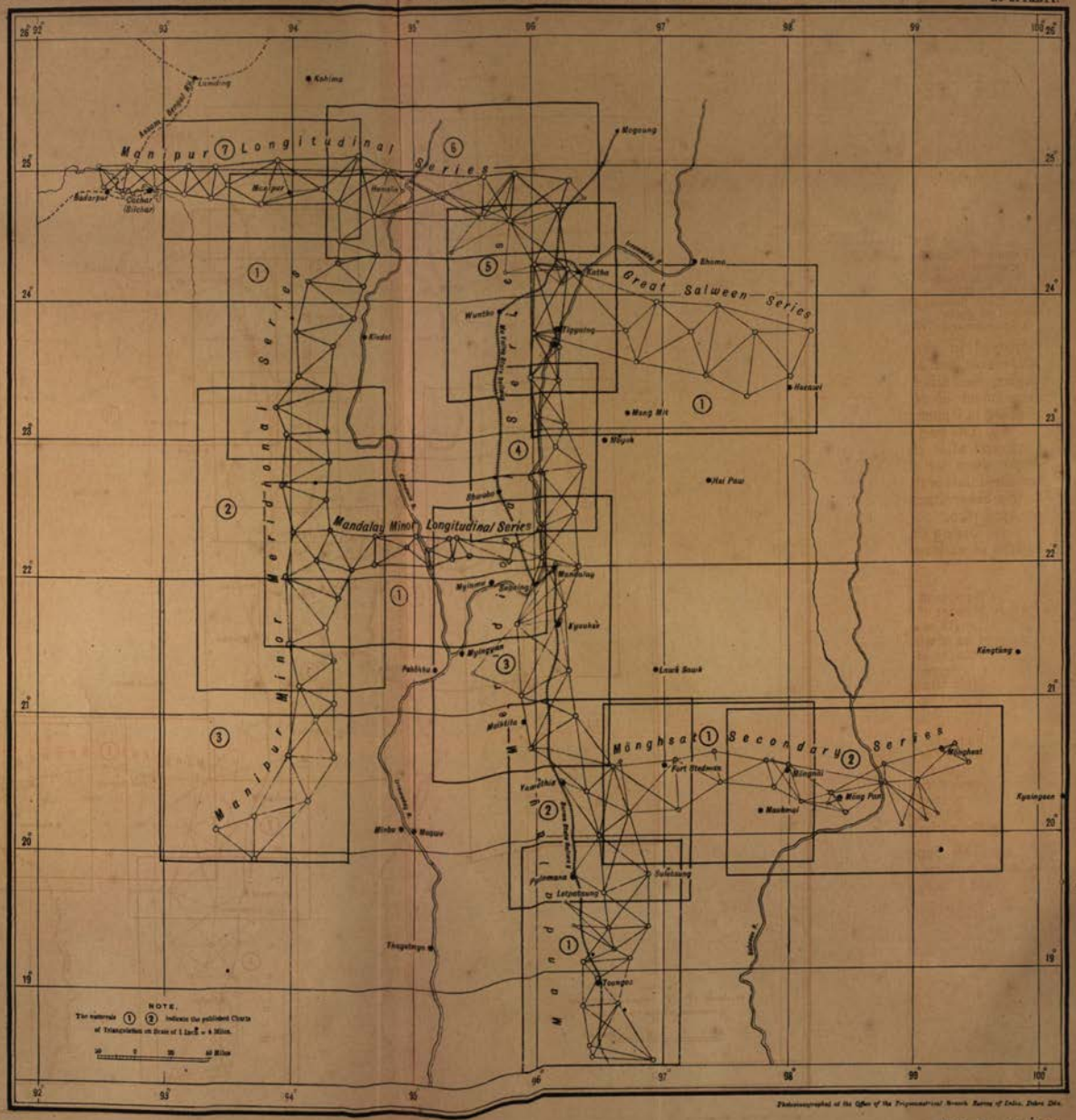
OF THE

MANDALAY MERIDIONAL AND LONGITUDINAL, MANIPUR MERIDIONAL AND LONGITUDINAL AND GREAT SALWEEN SERIES.

No. 24 PARTY.



Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún.

No. D.1. S. I. 18 - 5 - 1904 - 500

Reg. No. 41-S 04.

PART II.

THE OPERATIONS OF THE SEVERAL FIELD PARTIES.

TRIGONOMETRICAL SURVEYS.

INDIA TRIANGULATION.

NO. 24 PARTY.

Personnel.

Captain H. Wood, R.E., Officiating Deputy Superintendent, 2nd grade, in charge.
Mr. D. J. Hunter, Sub-Assistant Superintendent, 1st grade.
Mr. C. D. Simons, Sub-Assistant Superintendent, 3rd grade.
4 Recorders and 1 Writer.

87. The party remained under charge of Captain Wood (promoted from Lieutenant early in the year) during the season under review.

88. The programme was to continue eastwards the Great Salween series in Upper Burma, but previous to this it was employed in executing a small figure of triangulation on the hills north of Mussooree, and also in obtaining by means of simultaneous reciprocal vertical angles, the difference in height between two bench-marks of the Levelling detachment of No. 25 Party, one on either bank of the river Irrawaddy near Sagaing in Upper Burma.

89. The party took the field for the Mussooree work on September 20th, 1902, and after the completion of it left for Burma. Observations were not begun there for the principal triangulation till December 6th. The weather remained favourable for work until March 12th when haze and smoke prevented further observations being made. Mussooree, the recess quarters, was reached on April 16th.

90. During the recess the computations were completed. The season's outturn of work being—

PRINCIPAL TRIANGULATION.

Number of stations newly fixed	10
Number of figures completed	2
Length of series completed, in miles	80
Area of triangulation, in square miles	3,310
Number of stations at which astronomical azimuths were observed	1
Mean triangular error (12 triangles)	0·408

SECONDARY TRIANGULATION.

Number of stations newly fixed	3
Number of figures completed	1
Length of series completed, in miles	10
Area of triangulation, in square miles	120
Number of stations at which astronomical azimuths were observed	1
Mean triangular error (7 triangles)	1·444

91. The Superintendent, Trigonometrical Surveys, inspected the party in recess quarters on June 23rd, 1903.

TOPOGRAPHICAL SURVEYS.

LOWER BURMA.

No. 3 PARTY.

Personnel.

Mr. E. F. Litchfield, Officiating Superintendent, 2nd grade, in charge up to 22nd July 1903.
Mr. P. J. Doran, Extra Assistant Superintendent, 1st grade, in charge from 23rd July 1903.
Mr. J. Keating, Extra Assistant Superintendent, 4th grade.
Mr. C. George, Extra Assistant Superintendent, 4th grade.
Mr. W. M. Gorman, Extra Assistant Superintendent, 6th grade.
Mr. J. Donaghey, Sub-Assistant Superintendent, 1st grade.
Mr. E. Claudius, Sub-Assistant Superintendent, 2nd grade.
Munshi Asmatulla Khan, Sub-Assistant Superintendent, 3rd grade.
29 Sub-Surveyors, etc., and 1 Writer.

92. The party suffered a serious loss by the death of the senior assistant Mr. J. Keating, who died suddenly on the 4th December 1902, the morning after his arrival at Prome. He was an efficient, conscientious, and hard working officer.

93. The party left recess quarters at Bangalore between the 27th November and the 9th December, one triangulator being sent in advance on the 30th September. The field season closed at the end of May, and the recess office opened at Bangalore on the 12th of June.

Four camps were formed. The head-quarters camp at Prome, camp I working first in the Thayetmyo and Magwe districts and afterwards in the Hanthawaddy district, and camps II and III in the Henzada and Tharrawaddy districts. These three camps were each under a provincial officer.

94. The season's programme of work was as follows—

(*a*) The detail survey of sheets 204, 205, 206, 164, 165, 166, 211, 212, 213, 214, 215. This included the supplementary topographical survey (hitherto called "revision survey") of parts of these sheets which had been previously surveyed by the revenue survey.

(*b*) Triangulation and traversing in sheets 211 and 215 and parts of 164, 165, 166, for both detail and supplementary work.

With the exception of the supplementary topographical survey of sheet 215 this programme was successfully accomplished.

The area triangulated in advance which it is usual to provide for the detail survey of subsequent seasons has become dangerously small. This will be rectified by triangulating a large area during the coming field season.

95. The outturn is as follows—

	Square miles.
Detail survey on 1-inch scale	1,786
Supplementary topographical survey	2,934
Triangulation for detail survey	569
Triangulation for supplementary topographical survey	1,319
Traversing for detail survey	324

This outturn is considerably in excess of that of last year. The area covered by the supplementary topographical survey was composed almost entirely of the open highly cultivated paddy lands bordering the Irrawaddy and the railway line. The triangulation undertaken for the supplementary survey as stated in last year's report, was confined to the fixing of a few trijunctions, *pagodas*, etc., and providing heights.

96. The total expenditure of the party is ₹95,000 and the cost-rates per square mile are, as follows—

	R
Detail survey on 1-inch scale	21·8
Supplementary topographical survey	11·5
Triangulation for detail survey	8·1
Triangulation for supplementary survey	2·9
Traversing	12·1

The traversing consisted of a zig-zag line run down the middle of an unsurveyed area between the Irrawaddy and the Myitmakha stream, the periphery of which had been previously traversed. Hence the low cost-rate.

97. The season on the whole was a healthy one. There were no deaths and the cases of serious illness were few.

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BURMA SURVEY.

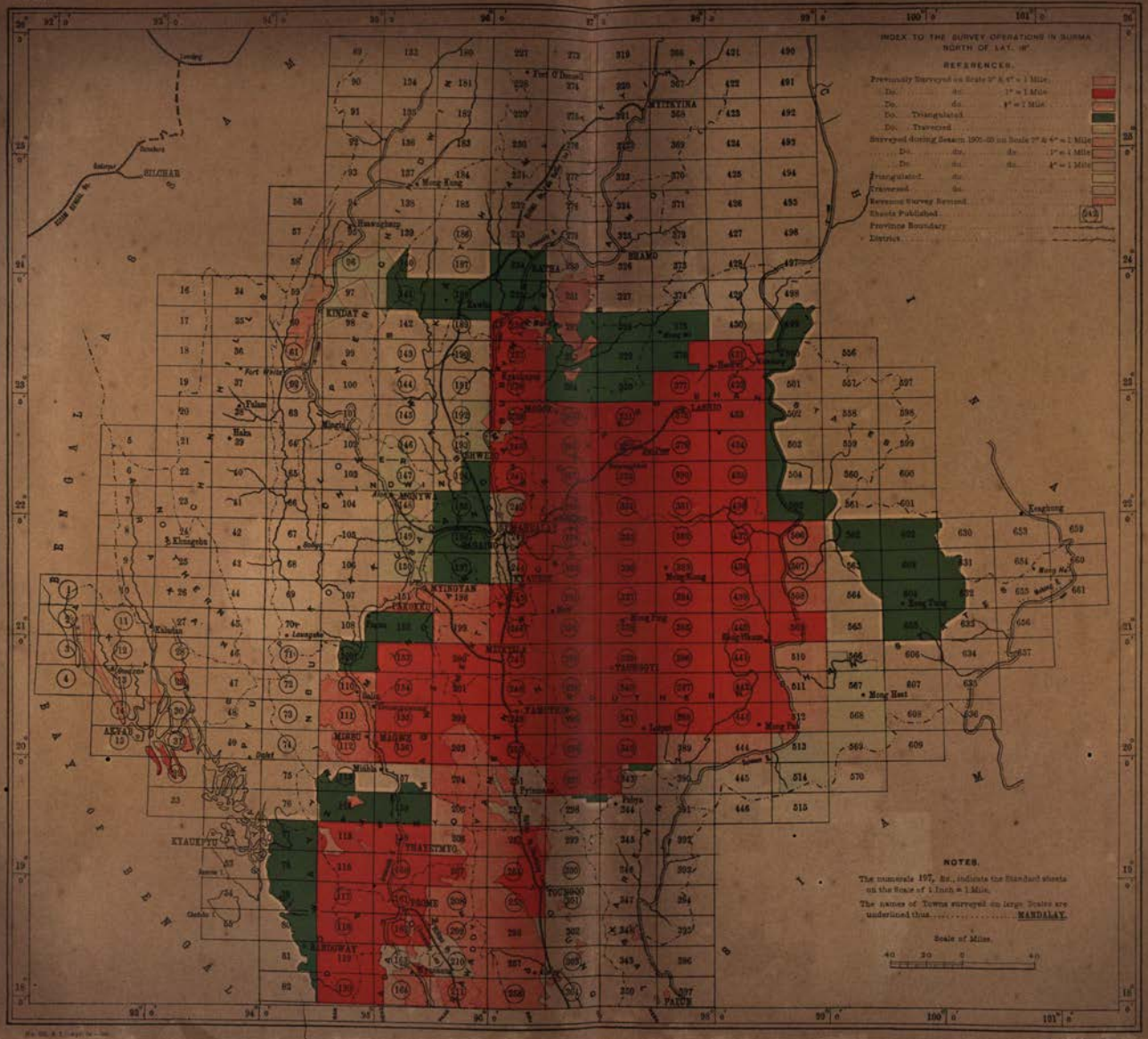
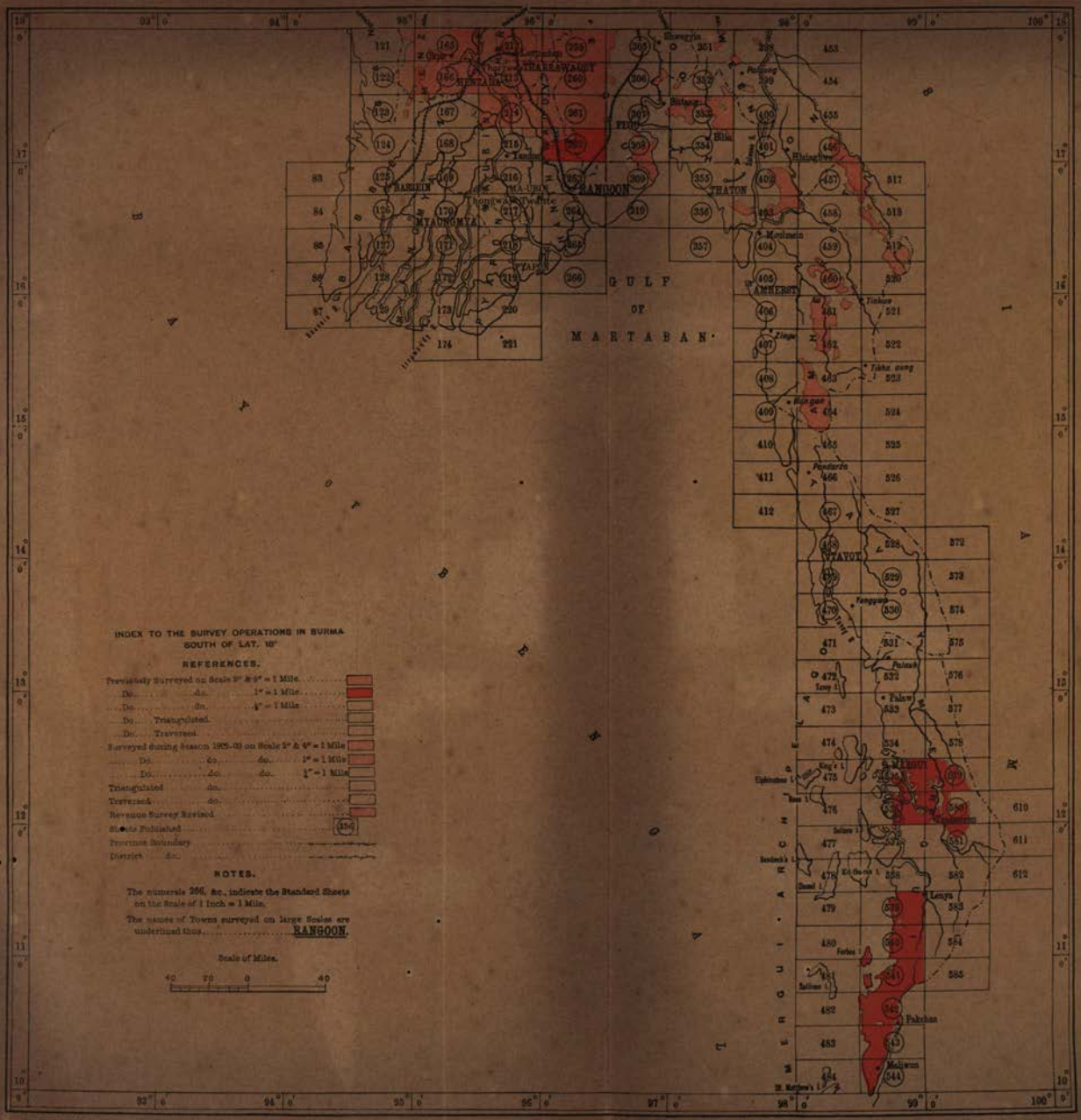


Photo. & L.O. Calcutta.

Reg. No. 657. S. 04.



INDEX TO THE SURVEY OPERATIONS IN BURMA SOUTH OF LAT. 18°

REFERENCES.

Previously Surveyed on Scale 2" & 4" = 1 Mile
Do. do. 1" = 1 Mile
Do. do. ½" = 1 Mile
Do. Triangulated.
Do. Traversed.
Surveyed during Season 1902-03 on Scale 2" & 4" = 1 Mile
Do. do. do. 1" = 1 Mile
Do. do. do. ½" = 1 Mile
Triangulated do.
Traversed do.
Revenue Survey Revised
Sheets Published (354)
Province Boundary
District do.

NOTES.

The numerals 266, &c., indicate the Standard Sheets on the Scale of 1 Inch = 1 Mile.

The names of Towns surveyed on large Scales are underlined thus RANGOON.

Scale of Miles.

40 20 0 40

Photo R. I. O., Calcutta

Reg. No. 658-S. 04

98. The country under detail survey in the Thayetmyo district was similar in character to that previously described. In the Henzada district this area was confined to the eastern slopes of the Arakan Yoma. In the Tharrawaddy district the detail was confined to the narrow strip of swampy grass land between the Irrawaddy and the Myitmakha stream. The area under supplementary topographical survey was composed mainly of paddy fields. Some important additions were made, such as the Letpadan Bassein railway line, some new roads, villages, cultivation, etc., but the revenue survey work was found to be extremely accurate.

99. The fair mapping, though still in arrears, has made more rapid progress than it did last year. Sheets 115, 117, 118, 120, 259, 260, 261 have been sent for publication; whilst sheets 116, 119, 159, 163, 204, 211, 212, 213, 214, 254 and 255 are ready for final examination. Sheets 164, 165, 166, and part of 207 will be completed in the Bangalore drawing office during next field season. The outlining of these sheets is finished and the hill drawing of all but one is well advanced. Sheets 119 and 163, though nearly ready last year, were kept back pending the settlement and survey of some boundaries. The spelling of the names was examined and corrected by the Government Translator in the Burma Secretariat.

100. The programme for field season 1903-04 is as follows:—

(1) Detail and supplementary survey of sheets 113, 114, 157 and 158, and eastern parts of 75 and 76, up to the crest of the Yomas.

(2) Triangulation and traversing in sheets 251, 252, 298, 299 and 300.

The following five years' programme has, with the approval of the Burma Government, been sanctioned for this party—

Year.	Programme.
1902-03 . . .	Completion of sheets 164, 165, 166, 204, 205, 206, 211, 212, 213, 214 and 215.
1903-04 . . .	113, 114, 157, 158, and eastern parts of 75, 76.
1904-05 . . .	Completion of 251, 252, 298, 299, 300.
1905-06 . . .	Completion of 301, 302, 303, 304, 305, 306.
1906-07 . . .	77, 78, 79, 80, 81, 82. (These sheets are already triangulated.)
1907-08 . . .	32, 33, 50, 51, 52, 53, 54, 55, and western halves of sheets 75 and 76.

101. The party was inspected by the Surveyor-General and Deputy Surveyor-General during the recess.

UPPER BURMA.

No. 10 Party.

Personnel.

Captain F. W. Pirrie, I.A., Officiating Deputy Superintendent, 1st grade, in charge from 7th December 1902.
Lieutenant A. A. McHarg, R.E., Officiating Deputy Superintendent, 2nd grade, in charge up to 6th December 1902.
Mr. R. Waller-Senior, Extra Assistant Superintendent, 4th grade.
" P. J. Barrington, " " " 5th "
" F. P. Walsh, " " " 6th "
" W. G. Jarbo, Sub- " " " 2nd "
" C. West " " " " 3rd "
20 Sub-Surveyors and 1 Writer.

102. Lieutenant A. A. McHarg, R.E., held charge of this party up to 6th December 1902 when he handed it over to Captain F. W. Pirrie, I.A., who held charge for the remainder of the year.

103. The party left recess quarters for the field in two detachments on 29th October and 5th November 1902 and arrived again at recess quarters in various detachments between 30th April and 25th June 1903.

104. The survey operations were of the same nature as those carried out during the past four years and consisted of topographical survey, over new ground on the scale of 1 inch = 1 mile and supplementary topographical survey on the same scale on the ground previously cadastrally surveyed in the districts of Meiktila, Myingyan, Kyauksè, Sagaing, Pakôkku, Magwe and Minbu.

Towards the close of the field season additions to the map of Maymyo on the scale of 16 inches = 1 mile were carried out and the map brought up to date for a second edition.

The work of the party was thoroughly supervised and checked by the officer in charge and his assistants during the field season.

105. The outturn for the field season was as follows :—

	Square miles.
Triangulation	3,403
Detail survey	3,336
Maymyo revision survey	19

The cost-rates per square mile were as follows :—

	R	a.	p.
Triangulation	12	1	3
Detail survey	19	1	11

106. Triangulation was carried out in the Pakôkku, Myingyan, Lower Chindwin, Sagaing and Shwebo districts for future detail survey.

The secondary series between the Great Trigonometrical Mandalay meridional series near Katha and the secondary Great Trigonometrical Manipur meridional series near Kindat for future topographical and forest surveys was completed.

The detail survey in the field comprises the following 1-inch standard sheets: 198, 199, 151, 110, 111, 112. The ground topographically surveyed varied much in character. In Myingyan, Meiktila, Sagaing, Kyauksè and Pakôkku districts the country was open and free from forest, while the ground was much cut up by ravines in Magwe and the view obstructed by large trees and forest in Minbu district which added to the difficulty of the detail survey. The area of both triangulation and detail survey was slightly less than that of the previous year owing to the difficulty of the triangulation in the Upper Chindwin and parts of Shwebo districts where eventually careful height traverses had to be substituted for triangulation, and the intricate nature of the ground surveyed in detail in Minbu district.

The additions required to the Maymyo map consisted of new roads, buildings, forest and other boundaries, and the work was carried out by a provincial officer and four sub-surveyors toward the close of the field season.

107. The health of the party was good as only one death from fever in the menial establishment took place during the field season. One sub-surveyor died at his home during recess, and the writer of the party died of plague at Bangalore just before the party left for the field in October 1903.

108. During recess the computations for those portions of the triangulation required for next season's work were completed, standard sheets 110, 111, 112, 202, 203, 198, 199 and 151 were fair drawn, and as many of these as possible will be sent for publication in November 1903. The second edition of the Maymyo map on the scale of 16 inches = 1 mile was completed and sent for publication. Atlas and degree sheet data were despatched to the Calcutta and Bangalore drawing offices, and the preparation of triangulation charts for publication proceeded with during recess.

109. The programme for next field season is as follows :—

The triangulation of the remaining portions of 1-inch sheet 109 and 148 and the whole of sheet 108 and perhaps 107, if time admits.

Theodolite height traverses in the portions of sheets 145, 147, 192, 193, 194, not already triangulated.

The officer in charge of the party will himself connect by triangulation the existing triangulation east of Kalewa and the secondary Great Trigonometrical Manipur meridional series to the west.

The detail survey on the scale of 1 inch = 1 mile, partly new and partly supplementary, of sheets 146, 147, 192, 193, 194, 195.

110. The following five years' programme has been sanctioned for this party and will be kept to as nearly as may be possible :—

Year.	Programme.
1902-03	Sheets 110 111, 112, 151, 198 and 199.
1903-04	„ 145, 146, 192, 193, 194 and 195.
1904-05	„ 147, 148, 149, 150, 196 and 197.
1905-06	„ 105, 106, 107, 108, 109 and 152.
1906-07	„ 101, 102, 103, 104, 73 and 74.
1907-08	„ 143, 144, 190, 191, 71, 72 and revision of western portion of sheets 242, 243 and 244.

111. The party was inspected by the Surveyor-General in September, who expressed himself pleased with the state of the work.

UPPER BURMA.

NOS. 11 AND 21 PARTIES.

112. The party remained in the charge of Mr. P. J. Doran till 5th February 1903, and from 6th February till 26th September, in that of Captain C. H. D. Ryder, R.E., who then received orders to make over charge to Mr. W. M. Kelly and proceed to join the Sikkim Tibet Mission in Sikkim. Mr. Doran was temporarily transferred to the charge of No. 3 Party on 23rd July 1903.

Personnel.

Captain C. H. D. Ryder, R.E., Officiating Superintendent, 2nd grade, in charge from 6th February to 26th September.
Mr. P. J. Doran, Extra Assistant Superintendent, 1st grade, in charge up to 5th February.
Mr. W. M. Kelly, Extra Assistant Superintendent, 3rd grade, in charge from 27th to 30th September.
Mr. J. H. Nichol, Extra Assistant Superintendent, 6th grade.
Babu Pramadaranjan Roy, Sub-Assistant Superintendent, 2nd grade.
Mr. P. A. T. Kenny, Sub-Assistant Superintendent, 2nd grade.
Mr. H. C. W. Stotesbury, Sub-Assistant Superintendent, 2nd grade.
Mr. V. W. Morton, Sub-Assistant Superintendent, 3rd grade.
24 Surveyors, Sub-Surveyors, etc., and 1 Writer.

113. The party left Bangalore at the end of October and reached the scene of operations about middle of December, the last man taking up work about the end of that month. They returned early in May.

114. The country surveyed in detail on the one inch scale was that portion of the Southern Shan States situated on the eastern side of the Salween river lying between Latitude 20° 10′ and 21° 0′ falling in sheets 510, 511 and 512 and that on the west of the Salween between Latitude 20° 0′ and 20° 15′ and Longitude 97° 30′ and 98° 30′ comprising sheets 389, 444 and part of 513. It was for the most part very hilly and covered with jungle and was fairly populated, averaging a village to every 10 miles, the cultivation mostly *taung-ya* (hill cultivation) producing sufficient for local consumption both in cereals and vegetables.

115. The work completed during the season under report is:—

	Square miles.
Triangulation for one inch survey	2,797
Detail survey on the one inch scale	2,432

The cost-rates per square mile were as follows:—

	₹	a.	p.
Triangulation for one inch survey	10	7	2
Detail survey on the one inch scale	28	3	8

The country triangulated for the one inch scale lying in sheets 567 to 568 and parts of 569, 609, 513 and 514 in its natural features resembled much th ground surveyed in detail, although the hills are higher and the low ground very broken, all covered with dense jungle, the low ground particularly being overgrown with brushwood and high grass.

The outturn, both of topography and triangulation, is very satisfactory considering the obstacles and difficulties which had to be overcome.

The surveys were rigidly tested and the men were constantly visited during the season; difficulties were overcome with the surveyors present and their errors shown them on the spot. The work has proved very good.

116. During the recess the party has completed the fair drawing for publication in two colours as well as in black only, all the one inch work surveyed during the season with the exception of a portion of that done in 513. In order to enable the hills to be printed either in black or in colour, blank spaces have been left in the hill shading where the names will fall in the completed map.

The computation of the triangulation has also been finished, and the results are satisfactory. The only arrears consist of the triangulation charts of the parties and these are being pushed on so as to be out of hand as quickly as possible. Seven of these charts have been completed for publication during this recess.

117. The health of the party was not as good as in previous years, there were several cases of fever and dysentery, some very sudden and severe. There were four deaths among the menials.

118. The Government having ordered that the whole of the Shan States up to the frontier should be surveyed on the one inch scale, the following programme has been sanctioned for the coming season

Detail one inch survey of sheets 568, 513 and portions of 569, and 609 up to the Shan-Siam boundary and of the portions of sheets 506, 507, 508, east of the Salween river.

Triangulation in sheets 564, 565, 604, 605 and remainder of 566.

119. The party was inspected by the Surveyor-General on 7th September who expressed his satisfaction at the state of the work.

SIND.

No. 12 Party.

Personnel.

Mr. C. F. Erskine, Deputy Superintendent, 1st grade, in charge up to 20th March 1903.
Lieutenant E. T. Rich, R.E., officiating Deputy Superintendent, 2nd grade, in charge from 21st March 1903.
Mr. G. G. Vander-Beek, Extra Assistant Superintendent, 2nd grade.
Mr. R. F. Warwick, Extra Assistant Superintendent, 4th grade.
Munshi Rahmatullah " " " 6th "
Mr. H. A. Charrier, Sub. " " " 1st "
Mr. E. C. J. Bond " " " " 1st "
Babu Dhani Ram " " " " 2nd "
Mr. B. M. Berrill " " " " 2nd "
45 Surveyors and Sub-Surveyors and 3 Writers.

120. Mr. Erskine was in charge of the party till the 21st March 1903, on which date he made over to Lieutenant E. T. Rich, R.E., who held charge of the party for the remainder of the year.

121. The survey operations were of the same nature as in the year 1901-02, and the following programme was completed:—

(*a*) A series of secondary triangulation running through the Kurrachee and Hyderabad districts in portions of sheets 53, 72, 73, and 92 connecting the Cutch coast series with the Kurrachee Longitudinal series of the South-West quadrilateral.

(*b*) Village boundary traverse survey in portions of sheets 34, 35, 52, 53, 54, 72, 73, 74, 92, 93, and 94.

(*c*) The detail survey on the 2-inch scale of portions of standard sheets 24, 25, 42, 43, 44, 78, 79, 80, 95, 96, 97, and 98.

(*d*) The detail survey on $\frac{1}{2}$-inch scale of the desert in portions of standard sheets 80, 81, 82, 97, 98, 99, 100, 112, and 113.

(*e*) The survey of the country round Jungsháhi amounting to 91 square miles on the scale of 4 inches to a mile.

(*f*) A survey of the Sámbhar Salt lake in Rájputána amounting to 178 square miles.

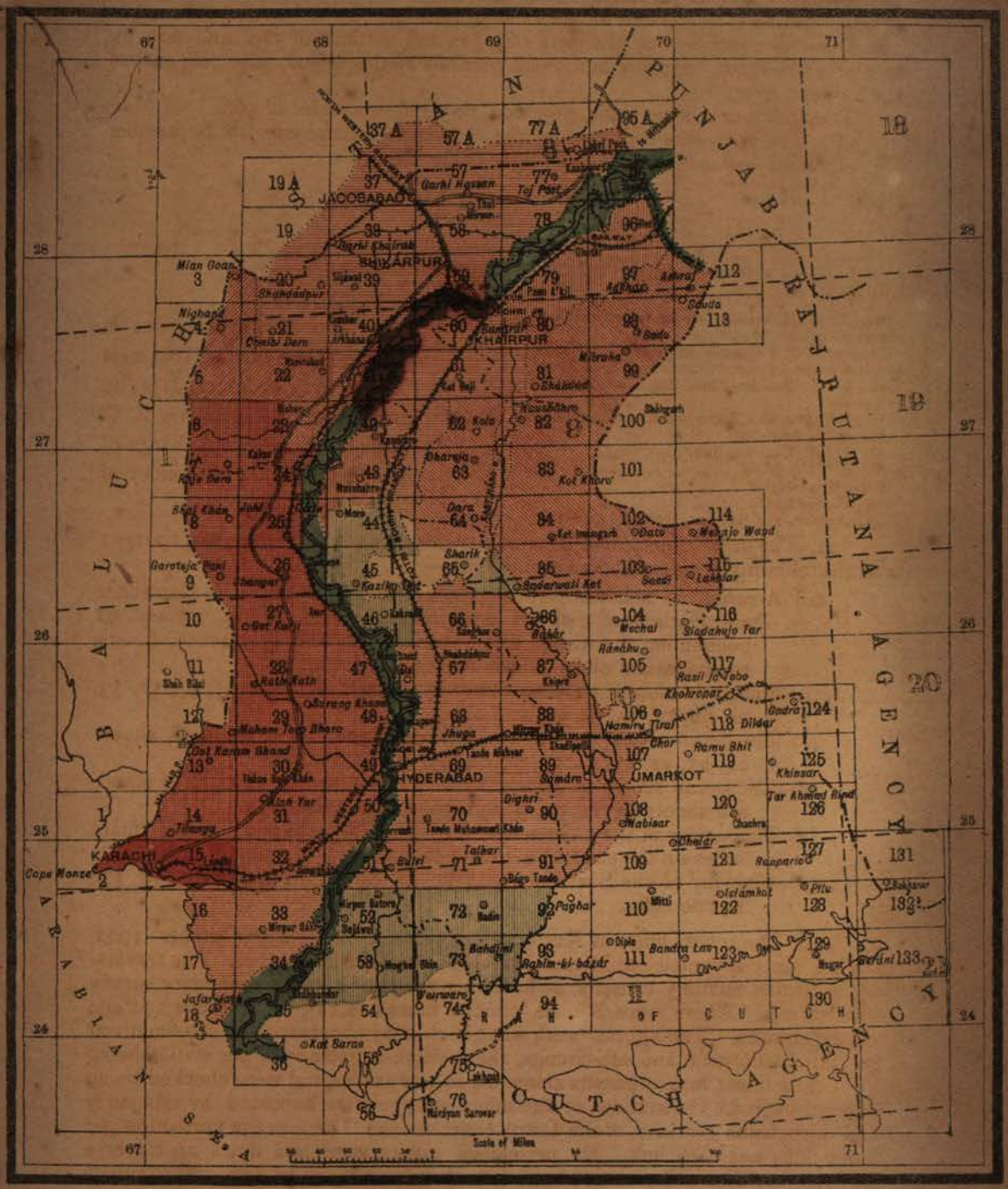
122. The recess office at Kurrachee was closed on the 29th October 1902, and the party assembled at Mirpur Mathelo on the 3rd November. The traversing in British territory consists, as in former years, of a village boundary survey with offsets. There were 8 main circuits measured, 13 sub-circuits and 494 village circuits. The angular work was checked by observations for azimuth at 80 stations on main and sub-circuits, the average angular error per station being 45″. The linear measurements amounted to 2,727 miles and were checked by 29 connections with the stations of the minor triangulation executed by this party and with some stations of the Cutch coast series. The average correction per 1,000 links was 0·46 link. No permanent marks were laid down at traverse stations, but the marks erected by the revenue authorities to demarcate village boundaries have been utilized and the angles of the village boundaries have been fixed by offsets. The cost of the traverse survey amounts to R13-12-2 per square mile.

123. The area surveyed in detail on the 2-inch scale amounts to 1,946 square miles, giving 49 plane-table sections. The survey was carried out entirely by interpolation. It was tested from 1,135 *in situ* fixings and was carried out under the direct supervision of the officer in charge. The cost of detail survey is R13-3 per square mile.

124. The survey of the desert in sheets 80, 81, 82, 97, 98, 99, 100, 112, and 113, on the half inch scale, was completed during the field season. The area surveyed amounts to 2,164 square miles, giving 5 plane-table sections. The

SIND SURVEY.

1902-1903 — Nos. 12 and 15 PARTIES



No. D. 143, E. I. 5 10-1903—500

Photolithographed at the Office of the Superintendent, Survey of India, Dehra Dun, February 1904

REFERENCES

Reg. No. 38-S 04.

Surveyed in previous Seasons Scale 1" = 1 Mile by No. 12 Party	
Do. do. 2" = 1 Mile do.	
Do. do. 4" = 1 Mile do.	
Do. do. 1/2 = 1 Mile do.	
Do. 1901-1902 2" = 1 Mile do.	
Do. do. do. 1/2 = 1 Mile do.	
Triangulated and Traversed in advance do.	
Surveyed in previous Seasons Scale 1" = 1 Mile by No. 15 Party	
Do. 1902-1903 1" = 1 Mile do.	
Indus Reserve Survey	

NOTES.

The numerals 63, etc., indicate the Standard sheets on the Scale 1 Inch = 1 Mile.

The figures and lines in circles represent the numbers and limits of the Engraved sheets of the Indus Atlas.

UNITED PROVINCES OF AGRA & OUDH.

1903-03.

INDEX TO THE CADASTRAL SURVEY IN THE U. P. A. & OUDH.

Nos. 2 & 3 & 14 PARTIES.

survey was carried out entirely by interpolation, and was tested from 161 *in situ* fixings. The cost of the survey is R5-8-1 per square mile.

125. The contoured survey of the country round Jungsháhi was undertaken and completed at the request of the Military authorities on the scale of 4 inches =1 mile. The area surveyed amounts to 91 square miles, giving 9 plane-table sections. The survey was carried out entirely by interpolation and the heights by the clinometer. It was tested by 87·5 miles of test line fixings. The cost of the survey is R48-8-1 per square mile.

126. The survey of Sámbhar Salt lake in Rajputáná on a scale of 2 inches=1 mile was undertaken and completed at the request of the Geological Survey Department. The area surveyed amounts to 178 square miles. The detail survey was carried out entirely by interpolation and clinometric heights were taken at nearly every fixing; it was tested from 97 *in situ* fixings. The cost of this survey was R15-2-8 per square mile, exclusive of preliminary triangulation and levelling.

Before detail survey was commenced a preliminary series of triangulation had to be run to give points in the vicinity of the lake. Spirit levelled lines were also run round and across the dry bed of the lake in order to be able to fix accurate one-foot contours all over it. These lines amounted to 170 miles in length.

127. Field work closed by the end of March and the party returned to Kurrachee for recess.

During recess the fair mapping of the entire area surveyed in detail on the 2-inch scale was completed. The mapping comprised 39 quarter sections. They were drawn on the 2-inch scale for reduction and have all been despatched to the Trigonometrical Office, Dehra Dún, for publication. Several of the fair maps of $\frac{1}{3}$-inch work have been completed and sent to Dehra for reproduction and publication and the remainder will be sent to Dehra Dún on completion of the drawing.

The fair maps of the Sámbhar lake survey have all been completed and sent to Dehra for reproduction and publication. The fair maps of the Jungsháhi survey were fair drawn at Dehra Dún and have already been published. The Upper Sind Frontier District map has also been drawn on the $\frac{1}{8}$-inch scale and sent to Dehra for reduction and publication on the $\frac{1}{4}$-inch scale.

The triangulation and traverse charts of sheets 24, 25, 26 and 52 have been drawn and despatched to Dehra with list of co-ordinates. Those of sheets 44, 53, 54, 72, 73, and 92 will be sent when completed.

128. Next season triangulation in advance will be taken up in sheets 86, 87, 104, 105, 106, 116, 117, 118, and 124, also a small net work in sheets 45 and 65 and another net work of triangulation in sheets 35, 36, 54, 55, 56, 74 and 75.

Traversing will be done in the sheets 44, 45, and 65, also traversing in connection with the resurvey of the Jamrao canal lands in standard sheets 66, 67, 68, 69, 88, 89, 90, and 91.

Detail survey on 2-inch scale will be carried on in sheets 26, 44, 45, 46, 65, and 85, also 52 and 72.

129. The health of the party during the field season was far from satisfactory, there being a great many cases of pneumonia. From this complaint one Sindhi writer and five *khalásis* died in the field and one *khalási* soon after he reached his home on leave.

130. The party was inspected by the Superintendent, Trigonometrical Surveys.

UNITED PROVINCES OF AGRA AND OUDH.

No. 14 Party.

Personnel.

Captain C. W. H. Symonds, I.A., Deputy Superintendent, 1st grade in charge.
Mr. E. J. Biggie, Sub-Assistant Superintendent, 1st grade.
" J. K. Newland, " " 2nd "
" J. H. Williams, " " 2nd "
" H. B. Simons, " " 2nd "
65 Sub-Surveyors, Computers and 2 Writers.

131. The programme was in continuation of that of season 1901-02, namely, the traverse and topographical survey of the Allahabad and Fatehpur districts, and the traverse and detail survey, on a scale of 12 inches = 1 mile, of Allahabad cantonments. The field office was

opened at Allahabad on the 26th of October. Work was carried on until the 2nd of May 1903 and the recess office opened in Mussooree on the 20th. During the field season Mr. E. J. Biggie supervised the field work. At the commencement of the field season Messrs. Newland, Williams, and Simons were employed on main circuit traversing. On the completion of this work, each of them carried out the detail survey of one plane-table section. They were then employed on testing the work of the plane-tablers in the field.

132. From the subjoined tabular statement will be seen a summary of the work completed together with the cost-rates of each different kind of work :—

District.	Demarcation.		Traversing.		Topographical Survey 2 inches = 1 mile.		Allahabad Cantonment Survey 12 inches = 1 mile.	
	Square miles.	Cost per square mile.	Square miles.	Cost per square mile.	Square miles.	Cost per square mile.	Square miles.	Cost per square mile.
		R a.		R a.		R a.		R a.
Allahabad .	833	3 0	833	26 10	1,885	6 7	6·02	Tra. 28 13 Top. 85 0
Fatehpur .	1,280		1,280		...	...	..	
Totals .	2,113	3 0	2,113	26 10	1,885	6 7	6·02	113 13

133. The origin of the survey used was, in the Allahabad district, the intersection of Longitude 81° 45′ 00″ and Latitude 25° 15′ 00″, and in the Fatehpur district that of Longitude 80° 45′ 00″, and Latitude 25° 45′ 00″. As a check on the angular work, observations for azimuth were made at 260 stations. Connections were made to 8 principal stations of the Gurwáni and Karára Meridional series. The average error was 3·75 feet per mile.

134. The area which came under traverse survey was divided into 8 main circuits and 11 river blocks. These were again divided into 86 sub-circuits, which were found to contain 2,019 villages giving an average area of 1·04 square miles in each village. In the above 2,019 villages, 1,286 sub-traverses were run. The following statement shows the number and description of each mark used :—

Stones	13,444
Cylinders	10,929
Pakka trijunction points	3,453
Pegs	429
Pakka pillars	1,985
Total	30,240

The demarcation was carried out in accordance with the method adopted last season.

135. All the traverse computations have been completed. The arrears of the Lushai triangulation have been completed and the records and triangulation charts despatched to Calcutta. There are no arrears in the traverse section.

136. The area which has been topographically surveyed on a scale of 2 inches = 1 mile, *viz.*, 1,885 square miles, is contained in sheets 140, 141, 154, 155, 156, 157, 167, and 168. Of these all have been completed with the exception of sheets 155 and 156. The former has not been completed owing to one plane-table section having to be rejected on account of bad work. This plane-table will be resurveyed during the coming field season. The number of linear miles of check survey amounted to 246·5 miles. Each square mile of survey contained an average of 26 plane-table fixings.

137. The following fair sheets have been drawn during recess on the scale of 2 inches = 1 mile for reproduction, and will be shortly sent to Calcutta for publication, *viz.*, sheets 141, 154, 155, 167, and 168. It has been decided to draw a separate set of standard maps on the 1 inch = 1 mile scale, in which village boundaries are to be omitted. The drawing of these maps will be taken up

during the ensuing field season. The detail survey on a scale of 12 inches = 1 mile of the Allahabad cantonments has been completed and the maps drawn on 3 sheets.

138. The country traversed and topographically surveyed was similar to that of last season and no special difficulties were met with.

139. The programme for the ensuing field season comprises the following :—

(*a*) Completion of the traversing of the Fatehpur and Cawnpore districts consisting of an area of approximately 2,700 square miles.

(*b*) The topographical survey on a scale of 2 inches = 1 mile of 2,000 square miles in the Allahabad and Fatehpur districts.

(*c*) Traverse and topographical survey of the Rewah-Allahabad boundary. Scale of survey not yet determined by the Local Government.

(*d*) The supplementary survey of those portions of districts Rae Bareli and Partabgarh, which fall within the standard sheets of Allahabad district surveyed during the season under report. This supplementary survey is experimental, in order to ascertain the value of the old maps, and whether the village trijunctions are to be found on the ground in the event of this party taking up the survey of the Oudh districts after completing Allahabad, Cawnpore, and Fatehpur, which seems highly probable.

(*e*) Revision survey of those portions of Mirzapur and Jaunpur districts and Rewah which fall in sheets 156, 157, 167, 168, 169, and 170.

140. The office was inspected in the field by the Deputy Surveyor-General in November 1902 and again in March. During the recess season it was inspected in August by the Surveyor-General.

NORTH-WEST FRONTIER.

No. 15 Party.

141. Mr. E. A. Wainright held charge of the party for the year under report with the exception of two months when Captain Beazeley held charge.

Personnel.

Captain G. A. Beazeley, R.E., Officiating Deputy Superintendent, 1st grade, in charge up to 2nd January 1903.
Mr. E. A. Wainright, Extra Deputy Superintendent, 2nd grade, in charge from 3rd January 1903.
Mr. J. McHatton, Extra Assistant Superintendent, 1st grade.
„ G. A. Knight, „ „ „ 3rd grade.
Munshi Imám Sharíf, K.B., Extra Assistant Superintendent, 6th grade.
Babu Amar Singh, Extra Assistant Superintendent, 6th grade.
Mr. H. C. H. Cooper, Sub-Assistant Superintendent, 1st grade.
Subadar Kanak Singh, „ „ 2nd „
Mr. E. B. West, „ „ 3rd „
25 Surveyors, Sub-Surveyors, etc., 2 Writers and 1 Hospital assistant.

142. During the year the following changes took place: Captain G. A. Beazeley, R.E., was sent with two surveyors to Somaliland, Sher Jung returned from Abyssinia, Kádir Sharíf and Gopál Singh were attached to the Sistán Mission. Munshi Imám Sharíf, K.B., was transferred to the party and Babu Amar Singh was transferred from the party and the party lost in the death of Muhammad Ali, a sub-surveyor of promise.

143. The party was divided into detachments for the following work :—

1. Sind one inch topography.
2. Triangulation in Balúchistán.
3. Traversing in Balúchistán.
4. Cantonment surveys.
5. Revision of sheets of the Khágan valley.

144. The programme submitted in last year's report has been fully carried out. In Sind the remainder of the topography allotted to the party, an area of 1,499 square miles was completed. In Balúchistán an area of 850 square miles was triangulated. The cantonments of Chakráta, Mian Mir, Umballa, Mooltan and Pesháwar with their bazars and the bazars of Ferozepore were surveyed on the 12 and 48-inch scales, amounting to an area of 45·70 square miles. An area of 1,033 square miles was revised in the Khágan valley.

145. A comparison has been now arrived at between contract labour and the use of trained soldier surveyors, in connection with the cantonment surveys. The balance of advantage seems to be in favour of the employment of soldier surveyors, especially if their services can be retained for a sufficiently long period to enable them to acquire skill in chain surveying. Their work, although slower than that of the contract surveyor is far more reliable and necessitates far less supervision.

146. During the past winter and during recess, the following fair mapping has been got through of the cantonment plans:—Nowgong, Jhánsi, Bareilly, Cawnpore, Agra and Meerut and bazars of Lucknow and Fatehgarh, have been drawn and were sent to press, but have been returned for additions now wanted by the Military authorities; the plans of Chakráta, Mooltan, Umballa and Peshá-war are in hand. Of the Sind survey one inch maps the following have been sent to press, *viz.*, sheets 3, 4, 20, 21, 24 and 25. Besides this fair mapping five sheets on the 6-inch scale have also been completed and are ready for press. The triangulation has been computed in duplicate and the traverse computations and records are up to date.

147. The programme for the ensuing season allows for the continuation of triangulation in Balúchistán and the continuation of the topography connected with it, also the continuation of the survey of cantonment plans and bazars, those of Ferozepore, Amritsar and Jullundur being surveyed this winter.

148. The office of the party was inspected by the Surveyor-General in August.

PUNJAB.

No. 18 Party.

149. The field season extended from the beginning of November to end of April. This was the second year of work in the Punjab plains, previous to which the party was solely occupied with Himalayan surveys. The initial difficulties arising from so complete a change in the style of work have been much enhanced by the distracting nature of the new requirements, which are most varied and far too widely scattered to be satisfactorily dealt with by one field party.

Personnel.

Major W. J. Bythell, R.E., Superintendent, 2nd grade, in charge up to 7th March 1903.
Captain E. A. Tandy, R.E., Officiating Deputy Superintendent, 2nd grade, in charge from 5th May 1903.
Mr. W. Robert, Extra Assistant Superintendent, 1st grade, in charge from 8th March to 4th May 1903.
Mr. G. C. Swiney, Extra Assistant Superintendent, 2nd grade.
Mr. J. O. Greiff, Extra Assistant Superintendent, 6th grade.
Mr. C. E. C. French, Sub-Assistant Superintendent, 1st grade.
Babu Maya Das Puri, Sub-Assistant Superintendent, 2nd grade.
59 Sub-Surveyors, etc., and 1 Writer.

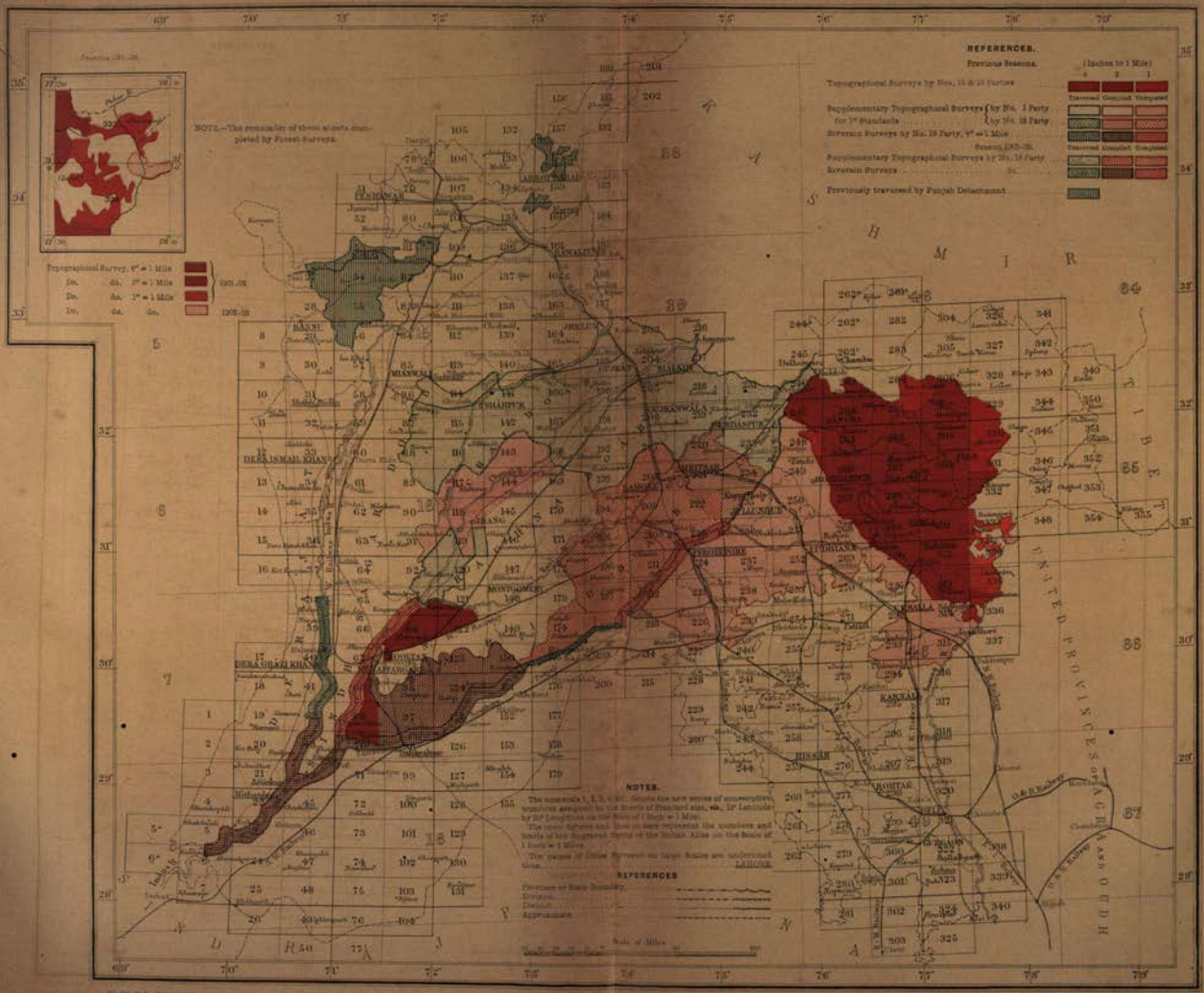
150. The different operations in hand during the year were as follows:—

(1) Completion of fragmentary remnants of previous Himalayan work in the Simla Hill States, Tehri-Garhwál, and Jaunsár Báwar.
(2) Supplementary topographical survey, for the preparation of standard sheets on the 1-inch scale, in parts of districts Montgomery, Lahore and Amritsar.
(3) Preliminary compilation and traverse work with the same object in district Mooltan.
(4) Riverain surveys on the 4-inch scale and preliminary compilations and traverse for the same, on the Chenab, Sutlej, and Indus rivers.
(5) The Simla boundaries survey, on the scale of 50 feet = 1 inch together with the demarcation and survey on the 6-inch scale, of the preliminary suggestions for the extension of the Simla Municipal limits.

151. *Himalayan surveys.*—These consisted in the completion of blanks in sheets 333 and 334 on the 4-inch, 2-inch, and 1-inch scales. Three sub-surveyors were employed on this work for two months in the autumn of 1902; and in May 1903 another man was sent to fill up some trifling omissions. The whole area embraced in the Himalayan work of this party has now been filled, and except for

PUNJAB & N. W. FRONTIER PROVINCE SURVEY.

1902-03. INDEX TO THE SURVEY OPERATIONS IN THE PUNJAB & N. W. FRONTIER PROVINCE. No. 18 PARTY.



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Engraved at the Survey of India Offices, Calcutta, 1903.

the possible necessity of strengthening weak portions, no more field work in this direction will be required until it is decided to extend the Himalayan surveys over fresh areas. On the other hand, there is a great deal of indoor work to be done; this will chiefly consist of redrawing, on 1-inch standard sheets, large portions of the work which have been so far only reproduced, as surveyed on 2-inch and 4-inch scales.

152. *Supplementary topographical surveys.*—Twelve plane-tablers were employed on this work for an average of 111 working days each. The area surveyed was 3,653 square miles, which works out at $2\frac{3}{4}$ square miles per man per working day; with scattered work, however, it is hardly safe to estimate for more than one plane-table, or 64 square miles per man per month, at the present rate of progress, though it is hoped that as the men become more thoroughly versed in this work, a higher rate may be attained. For the greater portion of the season Mr. Robert and Babu Maya Das Puri were employed in the supervision of the work, which was carried out on the principles described in last year's report. The cost of this portion of the work during the past season is estimated at R6-5 per square mile; this rate allows for the drawing of the fair sheets.

153. *Reduction of masavis and compilation of field sheets.*—Seventy-five 2-inch field sections, comprising an area of 3,700 square miles and 884 villages in the southern half of Mooltan were prepared during the year. Practically the whole work of reducing the original village *masavis* was carried out at Mooltan during the field season. The compilation and completion of the field sections, together with a small amount of miscellaneous Himalayan work, was carried out by Mr. Robert and 7 surveyors during 4 months of the recess season. The total cost works out at R2-9 per square mile.

154. *Traverse work in Mooltan district.*—An area of 3,150 square miles was completed at an estimated cost-rate of R8-8 per square mile. The field work was carried out by an average of nine traversers, working under Mr. Swiney, who also had charge of the various riverain traverses, as well as of the Mooltan office, where an average of 6 computers and 4 or 5 draftsmen and probationers were employed in the pantagraphing of *masavis* and the office work and computation of all the traverses. This district traverse was of especial interest, as it was a first attempt at utilizing the data of traverses nearly 50 years old, in place of carrying out a completely new traverse survey. The traverse operations carried out by the party, to knit together the old detached village traverses, consisted in the first place of seven main circuits connected with several trigonometrical stations on the Sutlej series and two others to the north of the work; these main circuits were sub-divided by further traverses into blocks of about 50 square miles area. The new traverse lines did not follow the village boundaries but ran from trijunction to trijunction, picking up all adjacent village *base lines* on the way. In parts of the district where there is much waste land, with forest reserves and what are called jungle villages, the old work is generally useless or non-existent, and here more or less complete traversing is necessary; especially as the new settlement *masavis* are also liable to be of inferior quality.

155. *Riverain surveys.*—These surveys are carried along the riverain tracts in which state and district boundaries have recently been once for all settled. The Settlement Department have found that their surveys, based on the *square* system, when advanced from two separate districts across wide riverain tracts where all marks are annually washed away, do not join up satisfactorily; so that they cannot get a reliable map of the tract, and have very little to go upon when attempting to relay boundaries or settle disputes. The assistance of this party has therefore been requisitioned with a two-fold object; first, to afford data by which important disputes may be authoritatively disposed of; and secondly, to provide a clear and definite plan of the riverain area. The essential difficulty lies in the evanescent nature of the facts to be recorded; not only do the rivers change annually, but the boundaries have to be hurriedly relaid every autumn by means of the local method of *squares*. The actual positions of the whole of the features of the riverain tract are therefore more or less variable from year to year. A complete and rigorous survey made at the time of settlement would solve these difficulties on paper, but this could hardly be arranged for under present conditions, and also the expense would be great. It was therefore decided to run two traverses, one along each high bank, picking up trijunctions and *base lines;* and to tie both together at intervals by cross

traverses of a similar nature. The idea was that the points so obtained should be plotted geographically on the 8-inch scale, and would be sufficient to enable the village *masavis*, reduced to that scale, to be satisfactorily built together. On trial, however, it was found that the *masavis* were not accurate enough for so large a scale, so that the apparent accuracy of the results would be fictitious. Further, it was found that with wide rivers, where numerous inferior *masavis* had to be built in between traverse points, several miles apart, no definite results of any kind were obtainable; this difficulty was much enhanced by the largeness of the scale, owing to which, in a river six miles broad, compilation had to be carried across many sheets of paper. For these reasons it was decided to reduce the scale to 4-inches, and to strengthen the original traverses by a certain amount of interior traverse work. Thus the previous traverses on the Chenab and Sutlej had to be strengthened last season before compilation could be effected; and even in the coming season a certain amount of supplementary work will be necessary in the traverses just completed. A further modification of the original scheme has been adopted, and consists of sending all work into the field after compilation, in order to obtain a satisfactory map of the country; this greatly improves the resultant maps, facilitates the settlement of vexed questions on the ground, and enables the work to be subsequently incorporated with the ordinary surveys of the party. During the previous year mark-stones were embedded at intervals in the traverse lines run along the high banks; but this practice has been abandoned from motives of economy. During the past season the riverain surveys of the Chenab west of Mooltan, and the portion of the Sutlej on the Ferozepore-boundary, were tested in the field and completed. The portion of the Indus bordering Muzaffargarh was traversed, and as far as possible the compilations for this portion and for the riverain tract extending from the south-west of Montgomery district to the south of Dera Gházi Khan were completed.

The area traversed was 1,158 square miles; map compilation was carried over 1,611 square miles; 697 square miles were tested in the field, and the fair drawing of nearly half of this was completed. The cost-rates of these operations work out at R8-8, R2 and R1-8 respectively; but owing to the incompleteness of much of the traverse and compilation the ultimate cost will be somewhat more.

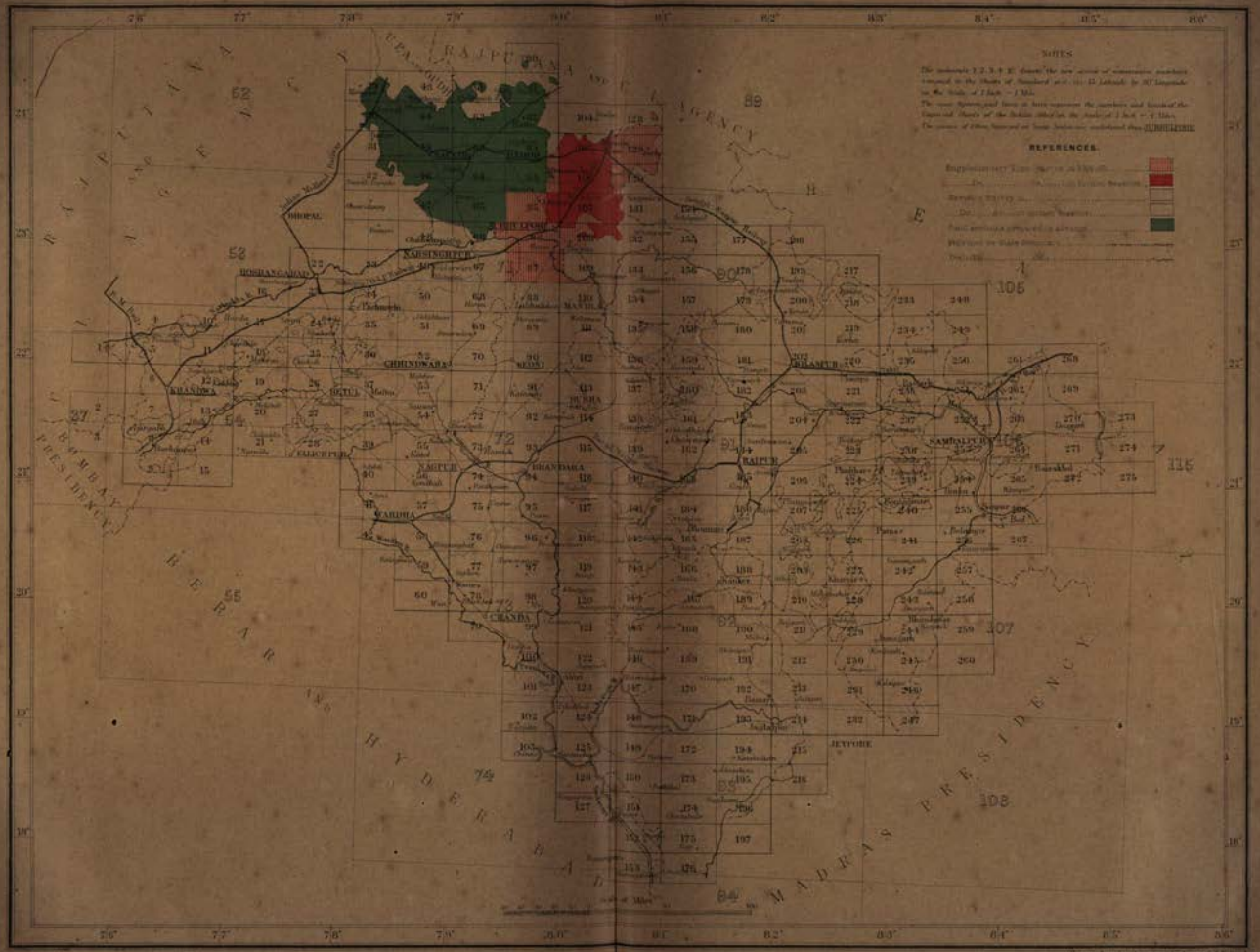
156. *Drawing section.*—The section was brought down for the field season and established at Mooltan. It was further hoped that economy, on account of fuel, Simla allowances, etc., and more work, owing to a temperate climate, might ensue from this measure. But practically such a move means a great dislocation of the work twice a year; while it is impossible to bring along the whole impedimenta, or to arrange for satisfactory accommodation, with a due regard for economy; so that the field drawing is carried on amidst innumerable difficulties. It has therefore been decided not to repeat the experiment at present. Mr. Greiff held charge of this section, but had to leave it on account of traverse work soon after arrival at Mooltan, and was away about a month. On return to recess quarters measures were taken to re-strengthen the section by the enlistment of new men, but the value of their services only began to be appreciable towards the close of the year. It was decided during recess to put aside all Himalayan work, and to concentrate the whole power of the section on the new surveys.

157. *Simla boundaries survey.*—The work of testing this survey by plane-table work in the field was completed in June. Twelve sheets have been held over till next year, so as to enable the railway, which is not yet completed, to be shewn; the remaining 97 sheets have been fair drawn and partially typed. The traverse computations have been completed, as also the calculation of the areas of the 420 estates comprised in the survey; the work of taking out areas of Government blocks is still in hand. Progress was somewhat interrupted during the spring by the Deputy Commissioner calling for a 6-inch survey of certain Simla extension proposals, which was accordingly done; it included the preliminary demarcation of about 25 miles of proposed boundary, much of which consisted of laying out contour lines through difficult ground. The whole of this work has continued in charge of Mr. French, whose wide knowledge of Simla boundary disputes and difficulties has been invaluable. The work should be finished next recess, unless further extensions of Simla have to be taken up.

CENTRAL PROVINCES SURVEY.

INDEX TO THE SURVEY OPERATIONS IN THE CENTRAL PROVINCES.

1902-03. C. P. DETACHMENT.



Registered under the superintendence of J. Pollard.

Addiscombe, 1901.

158. *Programme for next field season.*—It has become necessary to somewhat modify the original programme on account of the recent decision to adhere very rigidly to complete standard sheets, and, where new sheets consist partly of modern surveys, to roughly revise the latter so as to bring the whole sheet thoroughly up to date. Under these terms the immediate completion of Amritsar district has to be postponed; and the following programme has been adopted.

Supplementary topographical survey.—Southern half of Mooltan district and completion of sheet 221 in Amritsar. Traverse in Mooltan and the southern portion of Muzaffargarh district.

Compilation and reduction of masavis.—In districts Siálkot, Gurdáspur, Mooltan and Muzaffargarh.

Revision.—Portions of sheets 211, 212 and 223 in Ferozepore district, and of sheet 124 in Baháwalpur State.

Riverain surveys.—Traverses on Indus river, east of Dera Ismail Khan, Beas river, and Gujrát portion of Jhelum river, if time permits. Completion as far as possible of all portions previously traversed.

Simla survey.—Resurvey of sheets containing the new railway line, and completion of the whole work.

159. The party was inspected by the Deputy Surveyor-General in the field at Mooltan in December, and again by the Surveyor-General and Deputy Surveyor-General at Simla in June.

CENTRAL PROVINCES.

CENTRAL PROVINCES DETACHMENT.

Personnel.

Mr. R. C. D. Ewing, Extra Deputy Superintendent, 2nd grade, in charge.
Mr. G. J. S. Rae, Extra Assistant Superintendent, 6th grade.
Munshi Ikbaluddin, K.S., Sub-Assistant " 2nd "
33 Sub-Surveyors, etc., and 1 Writer.

160. The head-quarters camp was pitched at Garha, about 6 miles west of Jubbulpore, from which visits of inspection were made by the officer in charge.

161. The field operations of this season commenced on 15th October and comprised—

(*a*) the traversing of forest excisions and *samindári* villages which had previously been surveyed with the prismatic compass by local agency.

(*b*) the supplementary topographical survey and completion of district Jubbulpore left over from last season.

162. *Traversing* consisted of enclosing polygons in skeleton (*i.e.*, without measuring offsets to boundaries) of excised portions of forest reserves, and of "jungle villages" whose revenue at time of previous survey was less than R15, likewise the retraversing of *samindári* villages which had previously been surveyed with the prismatic compass by local agency. The theodolite was set up on as many prismatic compass stations of the *patwári* survey as could be found or identified. There was some difficulty in effecting this, as generally there were numerous stones, similar in appearance, but undistinguishable, whether station stones of the previous survey, or land marks set up by the villagers. The help of the *patwári* in such cases was indispensable. The extent of work done in each district is as follows:—

	No. of polygons.	Area in square miles.
District Saugor	2	1·1
" Seoni	130	126·4
" Nimár	4	9·8
" Chánda	93	274·8
" Raipur	120	162·7
" Betúl	1	0·9
" Bhandára	8	9·4
" Sambalpur	24	33·7
Jubbulpore Town and Cantonment	2	10·0
TOTAL	384	628·8

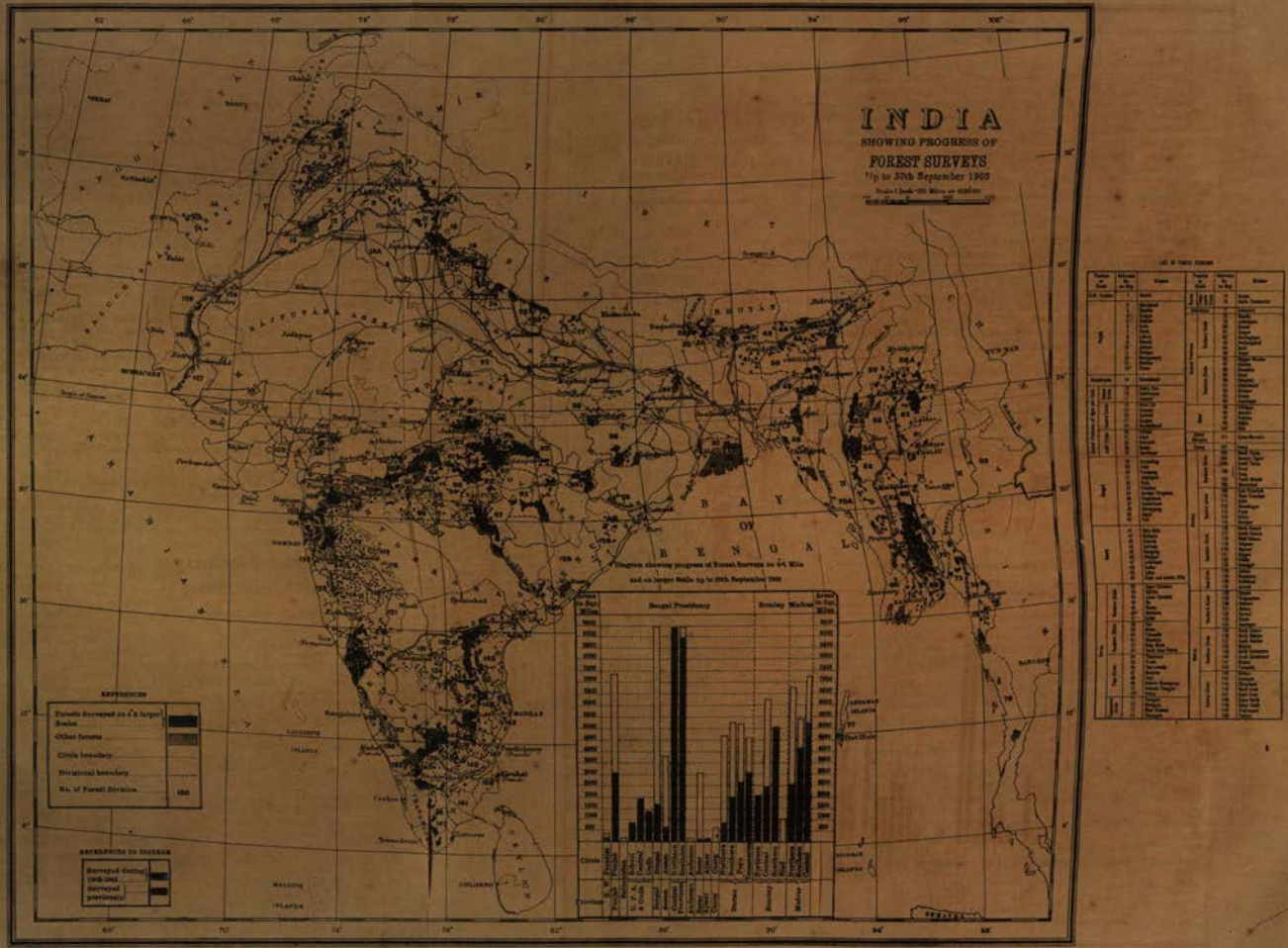
For this small area scattered through 9 districts, 8 traverse sub-surveyors were employed, which gives the average of 11·58 square miles per man per month. Owing to the scattered position of the villages, there was great loss of time in travelling by rail or marching from village to village, whereby the expense (cost-rate) was considerably increased. The polygons were too scattered to permit of main circuits, only one sub-circuit, checked by 3 azimuths, was surveyed in Raipur, *viz.*, *zamindári* Khujji. Numerous villages were situated in isolated positions within Government forest reserves in Raipur, and to locate them in their true positions, connecting lines through forest had to be measured, the bearings being checked by 4 azimuths. In all 10,054 angles were observed and 1,682 miles of chaining measured, checked by 9 azimuths. The average angular error is 3·6 seconds and linear error per 100 chains, is 6 links. There was only one G. T. Survey intersected point connected, *viz.*, Kumhár-ki-Toria temple in Jubbulpore cantonment. There were no others in the proximity of the detached villages under survey. The stations of the previous professional survey being marked by stones or platforms were generally found (except a few riparian ones), as also some of the satellite stations. The new stations are rough undressed stones, embedded about 2 feet under ground and 1½ above, marked at top with a circle and dot. The computations of the season's work have been completed and the records prepared for lodgement. 817 sheets of 384 villages have been plotted on the 16-inch scale and sent to the Settlement Department, with abbreviated sets up of traverse and rough index plots on 2-inch scale. The expenditure incurred amounts to ₹9,153-0-4 giving a cost-rate of ₹14-8-10 per square mile.

163. *Supplementary topographical survey.*—For supplementary topographical survey there were employed 18 sub-surveyors and 1 apprentice for half the season, and Mr. Rae from 9th December 1902 to 16th February 1903. The area surveyed on the 2-inch scale is as follows:—

	Square miles.
District Jubbulpore	1,748
„ Damoh	187
„ Seoni	157
„ Narsinghpur	182
Overlap into Native States	73
	2,347
Transferred to maps from reductions of forest surveys	487
	2,834

Included in the Jubbulpore area, 11 scattered villages of the Nagode State (Bundelkhand) covering an area of 27 square miles, have been surveyed to avoid gaps in the standard sheets. The work was tested by 813 interpolations and 310 miles of chaining. At the north-east corner of the district there was an insufficiency of heights. In this area, 5 stations and 46 intersected points were trigonometrically fixed, and their heights determined to aid the sub-surveyors in their contouring. 1,812 clinometric heights were deduced this season, which works out 0·8 per square mile of survey, the average difference *inter se* being 10·9 feet. The expenditure on supplementary topographical survey (2,347 square miles) amounts to ₹22,812-11-1 which gives a cost-rate of ₹9-11-6 per square mile. The daily average per man was 0·63 square mile and monthly average 19 square miles.

164. *Drawing section.*—This section was engaged as in the previous year, in the preparation of field sheets preparatory to their verification, correction, and completion of topographical details by surveyors in the field. The experience gained this year conclusively proves that the topographical details to be derived from the local agency cadastral maps, are practically *nil*, since the cultivated areas alone were surveyed, and these generally fluctuate from year to year, whilst all jungle and waste land areas had evidently never been entered, and were left blank. During the recess the old revenue surveys conducted by professional survey parties during 1854 to 1869 on the scale of 4 inches to the mile in districts Jubbulpore, Damoh, Seoni, and Narsinghpur were examined, and tested with the current season's surveys, when it was found that the difference



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December 1903.

Reg. No. 417-S. 03.

in the topographical features were hardly perceptible. The hills however were mostly shown by brush shading. It has therefore been decided to utilise, in future, the local agency maps only for plotting the village boundaries, and limits of cultivation, whilst the topographical details will be pantagraphed from the old professional 4-inch surveys. With this additional material, it is hoped that the rate of progress in the field, and general outturn will be sensibly increased, though it is still a moot question whether the cost of utilising old material by keeping up pantagraphing establishments, and verifying and supplementing this material in the field, is greater or less than the cost of a new survey.

The cost of the drawing section has been ₹5,967-12-7. The fair mapping has been completed in 11 standard sheets, and only requires final examination before submission for publication.

165. The programme for next field season is as follows—

(1) *Supplementary topographical survey* of district Saugor, and portions of Damoh, and Narsinghpur.

(2) *Revision survey* of such portions of Mandla district, Rájputána, and Central India as fall in the standard sheets of Jubbulpore, Damoh, and Saugor, so as to complete them up to margin, as up to date sheets in their entirety. This is effected by sending printed copies of these sheets to local officials, and asking them to roughly indicate thereon all changes, and any new public works, railways, roads, etc., etc., as may have been constructed since the publication of the sheets, and then by sending surveyors in the field to survey and locate this new material. In Mandla district, the village boundaries and forest reserves had been omitted in the old publications. These have now been inserted on the maps from the local agency and forest surveys.

(3) *Traversing* as in previous seasons, chiefly in Sambalpur district. The area for traversing being small, all the traverse sub-surveyors with the exception of one, have been transferred to other survey parties.

166. The party was inspected by the Deputy Surveyor-General in the field in December 1902 and again at commencement of recess in April 1903.

FOREST SURVEYS.

MADRAS PRESIDENCY.

NOS. 9 AND 19 PARTIES.

Personnel.

Captain C. L. Robertson, R.E., Officiating Deputy Superintendent, 1st grade, in charge from 9th September 1903.
Mr. H. Todd, Extra Deputy Superintendent, 2nd grade, in charge up to 15th June 1903.
Mr. G. T. Hall, Extra Assistant Superintendent, 2nd grade, in charge from 16th June to 8th September 1903.
Mr. W. F. E. Adams, Extra Assistant Superintendent, 6th grade.
Mr. J. H. S. Wilson, „ „ „ „
Mr. M. J. Sheehan, Sub-Assistant Superintendent, 1st grade.
Mr. C. C. Byrne, „ „ 1st grade.
Mr. H. A. Gibson, „ „ 2nd grade.
54 Surveyors, Sub-Surveyors, etc., and 2 Writers.

167. As in previous years the parties were divided into sections as follows :—

(1) Mr. G. T. Hall, with one assistant and 23 surveyors and apprentices, in Cuddapah district (Central circle).

(2) Mr. W. F. E. Adams, with 16 surveyors and apprentices in South Canara district (Southern circle).

(3) Mr. C. C. Byrne, with 16 surveyors and apprentices in Kurnool district (Northern circle).

(4) Mr. J. H. S. Wilson, with 4 surveyors and apprentices from the Cuddapah section in North Coimbatore district (Southern circle).

In addition to the above Mr. Sheehan and 5 sub-surveyors were employed on triangulation and traversing in Ganjam and Godávari districts.

168. The parties left their recess quarters at Bangalore in the beginning of November and, after a full working season of 6 months, closed field work in May. The Coimbatore detachment which did not take the field till January returned to Bangalore in July.

169. An area of 590 square miles was triangulated in South Canara in continuation of last season's work. In the Ganjam and Godávari districts 1,090 and 350 square miles, respectively, were completed. The difficult nature of the country and the scarcity of labour retarded the work in the latter district. In Ganjam, Mr. Sheehan did the triangulation, but in Godávari and South Canara, native agency was employed, and the results are generally satisfactory.

170. 538 linear miles of forest boundaries were traversed by theodolite in the Ganjam, Godávari, and South Canara districts. The area topographically surveyed on the scale of 4 inches to a mile amounts to 1,411 square miles including 111 square miles of resurvey of former season's work in Coimbatore. Owing to the thickness of the jungle it was found necessary to use the chain more extensively than formerly in the detail survey. An even more rigorous examination than usual was made and the quality of the work done was up to the standard of the department.

171. The country presented much the same difficulties as formerly. In South Canara, with its almost impenetrable undergrowth, work was tedious and slow. In Cuddapah the forest growth is heavy and the water exceptionally bad, and the Nallamalai hills in Kurnool, with their densely covered slopes, scanty population, and bad water, presented many difficulties.

172. The health of the party was bad, in the early portion of the field season being even worse than it was last year. In Cuddapah the unusually heavy rain in November impeded the operations and temporarily incapacitated several of the establishment. Fever and influenza were general for nearly a month at the commencement of the season, and several members of the section were constantly on the sick list throughout the season. South Canara proved as usual an unhealthy district and the section officer and many of his men suffered continually from fever. Two soldier surveyors and two sub-surveyors were sent on medical leave, and three sub-surveyors died during the year. Even during the recess the effects of the malaria contracted in the field were felt by the members of the parties.

173. During the recess the computations of triangulation and traversing, with few exceptions, were completed. 108 sheets, including 45 sheets partially completed last year, have been mapped. Owing to the incomplete verification of the forest boundaries, 10 sheets are withheld from publication in the Cuddapah district, 9 in Kurnool, and 2 in South Canara. The mapping of the revision survey of North Coimbatore is in progress. The Mysore-South Canara boundary is still undemarcated, but proposals have been made for the publication of a provisional issue of the maps in which the boundary occurs.

174. The actual expenditure for the survey year ending 31st August 1903, inclusive of cost of instruments is ₹8,038-8-8 in excess of that of the previous year. The increase is due principally to increased charges for local labour, carriage, and establishment. In spite, however, of the increase, the cost-rates of last season are fully maintained.

175. The following table shows the comparative cost-rates, and area surveyed for the last three years:—

	Area surveyed.			Cost-rates per square mile.		
	1900-1901.	1901-1902.	1902-1903.	1900-1901.	1901-1902.	1902-1903.
Triangulation . . .	1,335	1,680	2,030	6	5	5
Traversing	771	414	538(*a*)	8	14	13 (*b*)
Topography	1,378	1,306	1,411(*c*)	58	59	58 (*c*)

(*a*) Linear miles. (*b*) Per linear mile. (*c*) Including revision survey.

176. The programme for the ensuing season, comprises the continuation of the triangulation in Ganjam, Godávari and South Canara districts and of small area in Trichinopoly and Chingleput. The continuation of the traversing in South Canara, and the completion of the same in the Ganjam and Godávari reserves. The 4-inch detail survey includes the completion of the forests in Kurnool, continuation of the work in South Canara, and the commencement of the same in Ganjam and Godávari. The revision and examination of work in North Coimbatore will be continued.

177. The parties were inspected during September by Colonel St. G. C. Gore, R. E., Surveyor-General and also by Major P. J. Gordon, I. A., Superintendent, Forest Surveys. The season's work has been verified with the aid of the Government notifications by the District Forest Officers of Kurnool and Cuddapah, South Canara, and Coimbatore, who visited the office for that purpose.

BOMBAY PRESIDENCY.

No. 17 Party.

178. Mr. S. F. Norman held officiating charge of the party from the 1st to the 19th October 1902, when Mr. B. G. Gilbert-Cooper, on his return from Calcutta, where he had been officiating as Assistant Surveyor-General resumed charge and continued to hold it throughout the remainder of the year.

Personnel.

Mr. B. G. Gilbert-Cooper, Officiating Superintendent, 2nd grade, in charge from 20th October 1902.
Mr. S. F. Norman, Extra Assistant Superintendent, 3rd grade, in charge up to 19th October 1902.
Mr. C. A. Norman, Extra Assistant Superintendent, 4th grade.
Mr. C. J. Veale, Sub-Assistant Superintendent, 1st grade.
Mr. P. R. Anderson, „ „ 1st grade.
2 Surveyors, 37 Sub-Surveyors, etc., and 1 Writer.

179. The various detachments left Poona for the field at the end of November, and returned to recess quarters early in June, giving a full working season of six months.

The party was divided into three camps under Messrs. S. F. Norman, C. A. Norman, and C. J. Veale, respectively, and continued the survey on various scales of forest areas in the Northern, Central, and Southern circles of the Bombay Presidency, these operations comprising:—

(*1*) *Northern circle.*—Supplementary triangulation and detail survey on the 8-inch scale of teak reserves in the Thána district.

(*2*) *Central circle.*—Supplementary triangulation and detail survey on the 4-inch and 8-inch scales in the Násik district.
Detail surveys on the 8-inch and 16-inch scales in Ahmednagar district.
Supplementary triangulation in Khándesh and Sátára.
The 8-inch surveys were confined to the more valuable "teak" reserves and the 16-inch to the riverain "babul" reserves.

(*3*) *Southern circle.*—Detail survey on the 4-inch scale in Belgaum, Dhárwár and North Kánara districts.

The work of the party in the southern circle is now complete, it having been decided that the forests in Bijápur, the only remaining district, are not of sufficient value to justify the expenditure on a large scale survey.

180. The following table shows in detail the outturn, with cost-rates, for the year under report, and the two previous years:—

Description of survey.	Outturn.			Cost-rates.		
	1900-1901.	1901-1902.	1902-1903.	1900-1901.	1901-1902.	1902-1903.
Triangulation (No. of stations)	365	320	758	12·5	20	19
Traversing (linear miles)	315	504	...	7	8·7	...
Topography, 4-inch scale (square miles)	410	607	486·73	65·4	63·8	61
Topography, 8-inch scale (square miles)	255	161·5	239·97	106·7	136·1	130
Topography, 16-inch scale (square miles)	11	...	6·11	113	...	137

The cost-rates are slightly more favourable than those of last year, in spite of an increase in the cost of supervision, and may be considered satisfactory.

181. During the recess, good progress has been made in the mapping both of the current and of arrears of the former season's field work. The large outturn of 8-inch surveys, which covers four times the number of sheets the same area of 4-inch work would, makes it difficult to avoid having arrears, but every effort is being made to cope with them.

182. The programme for 1903-04 is in continuation of that for the past season. The 8-inch detail surveys in Thána and the 4-inch and 8-inch surveys in Násik will be continued. Triangulation will be continued in Sátára and Khándesh and the 4-inch detail survey will be commenced in Khándesh where the operations of the party will principally lie in the future, and in Sátára. In these districts it is intended to confine all detail surveys to the 4-inch scale instead of as in other districts surveying the teak forests on the 8-inch scale. Under favourable conditions the forest surveys of the Bombay Presidency, not including Sind, should be completed in 1907 or 1908.

183. The party was inspected in September by the Surveyor-General, and by the Superintendent, Forest Surveys.

BURMA.

No. 20 Party.

184. Captain A. H. B. Hume, R.E., held charge of the party from the 1st October to the 15th November 1902, when he proceeded on leave, and was succeeded by Captain A. Mears, I.A., who continued to hold charge for the rest of the year.

Personnel.

Captain A. H. B. Hume, R.E., Deputy Superintendent, 2nd grade, in charge up to 15th November 1902.
Captain A. Mears, I.A., Officiating Deputy Superintendent, 2nd grade, in charge from 16th November 1902.
Mr. W. H. Penrose, Extra Assistant Superintendent, 3rd grade.
Mr. P. F. Prunty, " " " 3rd grade.
Mr. M. C. Petters, Sub-Assistant Superintendent, 1st grade.
Mr. S. S. M. Fielding " " 2nd grade.
Munshi Amjad Ali, " " 3rd grade.
64 Surveyors, Sub-Surveyors, etc., and 1 Writer.

The party left Dehra Dún on the 15th November, but, owing to delays in the river journey by Government steamer, field work could not be commenced until the end of December. The field season closed in Upper Burma at the end of May and in Lower Burma, owing to the early rains, it was found necessary to stop work about two weeks earlier.

185. The party was divided into five camps as follows:—

(1) Mr. P. F. Prunty with 14 traverse surveyors and 5 computers in the Upper and Lower Chindwin, Myittha and Yaw divisions.
(2) Mr. W. H. Penrose with 15 detail surveyors, afterwards reduced to 10, in the Upper Chindwin division.
(3) Mr. M. C. Petters with 14 detail surveyors in the Myittha division.
(4) Mr. S. Fielding with 6 detail surveyors from No. 2 camp in the Upper Chindwin division from March.
(5) Munshi Amjad Ali with 3 traverse and 6 detail surveyors and 2 computers in the Thayetmyo division.

In addition to the above 6 surveyors and computers were detached for the traverse and detail survey of the Mepalè extension reserve in the Thaungyin division.

186. Subsidiary triangulation based on the Manipur Minor Meridional series was carried out over an area of 1,161 square miles. Mr. Fielding was employed on this work for the first two months of the season after which he was placed in charge of a detail camp in the Upper Chindwin and Mr. Prunty completed the triangulation in addition to supervising his traverse camp.

187. As in the previous season the densely wooded nature of the country necessitated the detail survey being entirely dependent on theodolite traverses. A total of 1,173 linear miles of traverse (inclusive of 139·6 linear miles revision) was run in the various divisions under survey, the theodolite being set up at 17,866 stations which were marked by posts. In addition to the horizontal angles, vertical angles were observed at each theodolite station to provide heights for the detail surveyors. Most of the traverses were computed in the field.

188. The forest area topographically surveyed on the 4-inch scale was (inclusive of 26 square miles of resurvey) 623 square miles, and comprised reserves of the Upper Chindwin, Myittha, Thayetmyo and Thaungyin divisions. The country was nowhere easy, being very hilly and thickly wooded, necessitating the almost exclusive employment of plane-table traverses in order to map the topographical details. Owing to the villages being few and far between and also to a partial failure of the rice crop, supplies were expensive and difficult to obtain. Small food depôts were established at the head-quarters of each camp for the use of their establishments. It is probable that these food depôts will have to be largely increased during next season.

189. The testing and examination of the area topographically surveyed kept pace with the work and, except in the Thaungyin division, all the field sections were *partálled* by one or more lines. The testing was in the proportion of one linear mile to every 2·27 square miles of detail survey.

190. The health of the establishment, more especially that of the detail camps, was indifferent, a large percentage of surveyors being laid up with fever from time to time. Sixteen deaths occurred from an epidemic of cholera which broke out amongst the *khalásis* on their way down to Rangoon, 3 *khalásis* died of fever and dysentery, one was drowned, and one was killed by one of the elephants belonging to the party.

191. During the recess months the triangulation and traverse computations were completed. The mapping of the current season's work has been as far as possible finished. Four sheets of which the full area has not been surveyed will be completed during the field season as materials become available. In all 25 sheets have been submitted for publication, including 4 sheets of the previous season's work.

192. The total cost of the survey operations for the year ending 30th September 1903, was ₹1,48,468 or ₹25,815 less than the expenditure for 1901-02. This decrease is in part due to the employment of Government steamers for the river journeys both to and from the field, and partly to the absence of heavy arrears of mapping and publication charges of previous season's work, and to a shorter field season.

193. The following statement shows the outturn and cost-rates for the year under report and the two previous seasons—

Description of Work.	Area surveyed.			Cost-rate in rupees per square mile.		
	1900-1901.	1901-1902.	1902-1903.	1900-1901.	1901-1902.	1902-1903.
Triangulation . . .	534	250	1,161	33·5	15·0	3·2
Traverse	1,237(*a*)	1,646(*a*)	1,173(*a*)	56·5(*b*)	53·5(*b*)	44·7(*b*)
Topography, 4-inch . .	873	724	623(*c*)	97·8	122·3	136·6(*c*)

(*a*) Linear miles and includes 139·6 linear miles of revision for 1902-1903.
(*b*) Cost-rate per linear mile.
(*c*) Includes 28·02 square miles of resurvey.

The cost-rates of triangulation and traversing show a satisfactory decrease over those of last year.

The general cost per square mile of 4-inch detail survey is ₹14 more than for last season. This is principally due to a shorter working season owing to the bulk of the party having been employed in the Upper Chindwin valley the journeys to and from which, attended as they were by unavoidable delays, formed an unproductive period during which there was no outturn for the pay and allowances of the men. The country under survey was uniformly of a most difficult nature from a surveyor's point of view, rugged ridges and deep valleys, both covered with the densest forest growth, made progress necessarily slow. Added to this there was much sickness among the surveyors and their men and supplies were often scarce and difficult to obtain. After mentioning these circumstances which were the cause of a small outturn which more than anything else affects the rates, it is unnecessary to do more than merely refer to such matters as a non-effective charge on account of the pay of Captain Hume while on privilege

leave as well as the pay of his successor having to be taken into account in calculating cost-rates. The fact of the services of one of the assistants of the party having been required for a trans-frontier mission and his successor being a highly paid officer with no recent experience of forest survey work may also be mentioned in this place as it affected both outturn and rates.

Had not the officer in charge and most of the members of the party worked energetically and cheerfully under trying circumstances the cost of the detail survey, high as it is, would have been still higher.

194. In country such as the Upper Chindwin valley a higher rate of progress than 3½ square miles of detail survey a man a month or a field season of more than five working months cannot be looked for when estimating the outturn to be expected during the year.

195. The programme for 1903-04 is as follows:—

1. Triangulation and traversing in the reserves of the Lower Chindwin division and 4-inch detail survey in the Upper and Lower Chindwin and Myittha divisions.
2. Traversing and 4-inch detail survey in the Thayetmyo division.

196. The Superintendent, Forest Surveys, inspected the party in the field during the month of February and in recess in August.

OPERATIONS OF THE FOREST SURVEY BRANCH.

197. Major P. J. Gordon, I.A., during the year held administrative charge of the Forest Surveys, Bengal Presidency, which, under the orders of the Inspector General of Forests and the professional control of the Surveyor-General, continued the survey of forests in the several Provinces of the Bengal Presidency.

198. The operations of the various detachments are briefly reported on in the following paragraphs, and the full details will be published as usual in the Annual Progress Report of the Forest Surveys, Bengal Presidency.

199. *Central Provinces.*—A detachment consisting of seven surveyors under Babu Odey Singh completed the survey of the Chánda forests and with it of the forests of the Central Provinces.

Personnel.
Surveyor Odey Singh and 7 Sub-Surveyors.

The outturn and cost-rates in Chánda for the year under report and the two previous years are given in the following table:—

Description of work.	Outturn.			Cost-rate.		
	1900-1901.	1901-1902.	1902-1903.	1900-1901.	1901-1902.	1902-1903.
				₹	₹	₹
Triangulation(*a*) .	293	816	...	3·1	1·6	...
Traversing(*b*) .	76	231	58	7·6	6·0	8·4
Levelling(*b*) .	686	1057	171	1·4	1·7	5·9
16-inch boundary survey.(*b*)	740	872	211	2·0	2·1	7·7
4-inch detail survey.(*a*)	776	725	226	28·1	27·5	25·7

(*a*) Square miles. (*b*) Linear miles.

The results are satisfactory, the cost-rates for detail survey being the lowest yet reported. The higher rates for the other operations are due to the small area dealt with and to the scattered nature of the work.

The total expenditure for the year was ₹20,637 as compared with ₹63,943 in the previous year.

The mapping and publication of the Central Provinces sheets has made good progress. Eighty-three sheets were sent to press during the year and 137 have been published.

200. *Bengal.*—A detachment consisting of 12 surveyors under Mr. B. R. Hughes commenced the survey of the forests in the Kurseong, Darjeeling, and Kalimpong divisions of the Darjeeling district.

Personnel.
Mr. B. R. Hughes, Extra Assistant Superintendent, 5th grade.
12 Sub-Surveyors.

The outturn and cost-rates are given below :—

Forest Division.	4-INCH DETAIL SURVEY.		TRIANGULATION.		TRAVERSING.		Total expenditure.
	Area	Cost-rate.	Area.	Cost-rate.	Outturn. Lin. miles.	Cost-rate.	
		₹		₹		₹	₹
Darjeeling . Kalimpong . Kurseong . .	232	64	330	5	102	18	18,268

The outturn is satisfactory and the rates are reasonable.

The detachment will complete the survey of these divisions during 1903-04.

201. The mapping of the Singhbhum sheets is complete and these only await the verification of the boundaries of protected forests before being sent to press. Seven sheets have been already sent to press and four have been published during the year.

A preliminary outline edition of the map of the Kodarma forests has been published in order to facilitate the granting of new mica mine leases, the demarcation of which will be done in October next by some surveyors lent to the divisional Forest Officer for the purpose.

202. *Burma.*—In addition to No. 20 Party a traverse and a detail detachment of forest surveys consisting of 27 surveyors under Messrs. A. Ewing and C. Litchfield, were employed in Burma in the Mandalay, Ruby Mines, and Bhamo districts.

Personnel.
Mr. A. Ewing, Extra Assistant Superintendent, 5th grade.
Mr. C. Litchfield, Extra Assistant Superintendent, 6th grade.
27 Sub-Surveyors.

The outturn and cost-rates were as follows :—

Districts.	4-INCH DETAIL SURVEY.		TRIANGULATION.		TRAVERSING.		Total expenditure.
	Area.	Cost-rate.	Area.	Cost-rate.	Outturn. Lin. miles.	Cost-rate.	
		₹		₹		₹	₹
Bhamo . . Ruby Mines . . Mandalay . .	303	64	450	10	810	37	55,316
Totals for 1901-1902.	274	86	...	...	190	29	30,695

The area surveyed was not of a difficult nature and the health of the detachments was uniformly good. Little time was lost in reaching the ground and, in spite of several moves from one district to another during the period, a full working season of six months was obtained. The rates were satisfactory.

A surveyor was also sent to Ataran district to resurvey and test part of the Mepalè reserve, the survey of which had been done some years ago and was reported inaccurate by the Forest Officer in charge working plans.

Fifteen maps were sent to press and fourteen were published during the year including four working plan maps.

During 1903-04 the same detachments will continue their operations in Mandalay, Ruby Mines, and Katha districts.

Personnel.
Surveyor Udey Ram.
" Bhup Singh.
13 Sub-Surveyors.

203. *Punjab and North-West Frontier Provinces.*—The following statement shows the nature and extent of operations in these Provinces :—

Districts and States.	4-INCH DETAIL SURVEY.		TRIANGULATION.		Total cost.	REMARKS.
	Area.	Cost-rate.	Area.	Cost-rate.		
		₹		₹	₹	
Jubbal and Tarhoch	27	47	...	...	1,279	Four surveyors under Babu Udey Ram.
Gujrát	60	34	110	3·5	3,806	Nine surveyors under Babu Bhup Singh.
Ráwalpindi	40					
Hazára	173	24	30	9	4,453	
Chamba	...	...	...	...	1,962	Mapping and publishing charges, and 98 linear miles of boundary surveys.
	300	...	140	...	11,500	

The outturn and rates are both satisfactory.

Next season the outline survey of the Jhelum and Shahpur forests will be taken in hand and the detail survey of the forests in Hazára will be continued.

Twenty-two 4-inch sheets of Chamba were sent to press and the same number published during the year.

204. *United Provinces of Agra and Oudh.*—A small detachment of surveyors under Babu Udey Ram was employed on the survey of newly reserved areas in the Ganges, Kumaun, Garhwál, and Naini Tal forest divisions.

Personnel.
Surveyor Udey Ram and Sub-Surveyors.

The outturn and cost-rates were as follows :—

Forest Division.	4-INCH DETAIL SURVEY.		TRAVERSING.		LEVELLING.		Total expenditure.	
	Area.	Cost-rate.	Outturn. Lin. miles.	Cost-rate.	Outturn. Lin. miles.	Cost-rate.		
		₹		₹		₹	₹	
Kumaun Garhwál Ganges Naini Tal	100	29·7	165	5·7	23	2·4	3,971	
Pilibhít Kheri Gorakhpur Bahraich	...	...	...	...	...	...	884	Mapping and publishing charges.
TOTAL							4,855	

Most of the old revenue survey traverse stations had disappeared and it was found necessary to do a considerable amount of traversing. This somewhat delayed the work and there remains in consequence a small area to be completed next season.

UNITED PROVINCES OF AGRA & OUDH.

1902-03. INDEX TO THE TRAVERSE SURVEY IN THE U. P. A. & OUDH. Nos. 2 & 8 & 14 PARTIES.

Published under the direction of Colonel H. R. Thuillier, R. E., Surveyor General of India.

Survey of India Offices, Calcutta, Sept. 1903.

Additions to 1903.

Engraved in the Survey of India Offices, Calcutta, 1903.

Nº 558-L 33

Three sheets of the United Provinces Survey were sent to press and 13 published during the year. There has also been a good deal of work done in entering newly surveyed boundaries by hand on the printed maps.

When the working plan details have been received from the Forest Department the new edition of the Kumaun-Garhwál series of forest maps will be taken in hand.

Personnel.

Mr. J. Marten, Extra Assistant Superintendent, 4th grade.
15 Sub-Surveyors.

205. *Assam.*—A detachment consisting of 15 surveyors, under Mr. J. Marten, commenced the survey of the reserves in the Gáro Hills and Kámrúp.

The outturn and cost-rates were as follows :—

Forest Division.	4-INCH DETAIL SURVEY.		TRAVERSING.		TRIANGULATION.		Total expenditure.
	Area.	Cost-rate.	Outturn Lin. miles.	Cost-rate.	Area.	Cost-rate.	
		₹		₹		₹	
Gáro Hills . . } Kámrúp . . }	134	97·8	117	33	70	37	19,668

The cost-rates are high, but this was almost unavoidable owing to the difficult nature of the country and its unhealthiness, which caused much sickness among both surveyors and *khalásis*, much time being lost in consequence. Local labour could not be obtained and the *khalásis* were imported from Chota Nágpur. Every effort will be made to reduce the cost of the work in this Province, but very cheap rates cannot be looked for.

206. The tendency in all surveys is to take up the easier and more healthy districts first and this course is justified as it enables the surveyors to gain, under favourable conditions, the experience and training which are more than ever essential for work in more difficult country. This is the case in the forest surveys of the Bengal Presidency whose remaining programme now lies in Burma, Assam, and Bengal, where the large outturn and cheap rates which were possible in the open forests of the Himalayas, Oudh, and the Central Provinces, can never be maintained. Had the work in the former areas been taken up first progress would have been still more slow and cost-rates much higher than they are at present.

Taking everything into consideration the general results may be considered satisfactory. In easy country cost-rates are lower than they have ever been before and the higher rates in more difficult districts admit of a satisfactory explanation.

CADASTRAL AND TRAVERSE SURVEYS.

UNITED PROVINCES OF AGRA AND OUDH.

NOS. 2 AND 8 PARTIES.

207. The preparation of cadastral maps and preliminary records-of-rights in districts Mainpuri, Azamgarh, and Jálaun has been brought to a close, and the cadastral establishments concerned have now been transferred to Moradabad, Bánda, and Hamírpur, to commence survey and record operations in these districts. Under the system in force, by which the survey and record writing in each *patwári's* circle extend over a period of two years, it is not possible to give accurate cost-rates of the work during the last year of operations in a district, and the cost-rates given below are those for the complete survey and record writing in each district.

Personnel.

Captain W. M. Coldstream, R.E., Officiating Deputy Superintendent 1st grade, in charge.
Mr. L. F. Berkeley, Extra Assistant Superintendent, 4th grade.
" J. M. Kennedy " " " "
" P. C. H. Smart " " " "
" F. C. Bell " " 5th "
" F. B. Powell " " " "
" J. H. Murphy " " 6th "
" C. S. Littlewood, Sub-Assistant Superintendent 1st "
21 Sub-Surveyors, Computers, etc., and 2 Writers.

208. *Cadastral surveys—Mainpuri.*—The maps and preliminary records of *tahsils* Shikohabad and Mustafabad, have been completed during the year and made over to the Settlement Officer. Operations commenced in the district in October 1899. The area surveyed is 1664·47 square miles, the total expenditure has been R1,52,894-14-2, and the cost-rate for combined survey and record-writing is R91-14-9 per square mile, or about R47 for survey, and R40 for record-writing. Only 20 square miles of survey, and 611 square miles of record-writing in the field remained for completion during the past year. The survey of the ravines intersecting the left bank of the Jumna was beyond the capabilities of the *patwáris*, so when they had finished the survey of the cultivation and village sites, a small establishment of *amins* was employed to undertake the ravines. An area of 34 square miles was topographically surveyed in this manner, at a cost of R14-8-0 per square mile. Of the 220 *patwáris* in *tahsils* Shikohabad and Mustafabad, 211 qualified as cadastral surveyors, 18 were allowed to depute their heirs for training and assist in their work, whilst substitutes had to be provided for 2.

209. *Azamgarh.*—All field work in this district was practically finished last year. The maps and records-of-rights of *tahsil* Muhammadabad, were completed during the past year and made over to the Settlement Officer. Survey and record operations were begun in October 1898. The area surveyed is 2156·76 square miles, the total expenditure R1,21,132-2-3, and the cost-rate is R56-2-5 per square mile. These figures, however, do not include the pay and allowances of Mr. Freeman, the officer in charge, during the first four years of the work. Mr. Freeman having previously been transferred to the Provincial Civil Service, these charges were not borne by the survey budget. If they were included, the cost-rate would be about R72.

210. *Jálaun.*—An area of 175 square miles remained for survey, and 218 square miles for record-writing during the past year, and the maps and records of *tahsils* Jálaun and Kúnch, were completed. Operations commenced in the district in October 1900. The area surveyed is 1,469 square miles and the expenditure R1,17,617-4-6. The cost-rate is R80-1-0. At the request of the Director of Land Records and Agriculture, each *patwári* in the district has been provided with a complete set of survey instruments to enable him to maintain his maps. If the value of these instruments is excluded from the expenditure, the cost-rate is R74-3-0 per square mile. As in Mainpuri, some professional assistance had to be given to the *patwáris*, and 11 *amins* were employed for a portion of the field season in surveying ravines. The attendance of the *patwáris* at office during the recess season, has been particularly bad in this district, in spite of the fines inflicted by the Collector and Survey Officer, and at one time it appeared doubtful whether the work could be completed within the period allotted by the programme. This has, however, been accomplished and all maps and records have been made over to the Settlement Officer.

211. *Traverse surveys.*—This section under Mr. F. S. Bell completed the traverse survey of 140 square miles in Moradabad district at a cost-rate of R29-7-10 per square mile. One hundred and fifty-five linear miles of main circuit traverses were also run in advance, along the high banks of the Rámganga and Dhela, in order to allow of both the traverse and cadastral surveys of the alluvial tracts of these rivers being carried out next season. The cost-rate for these additional traverses was R11-9-7 per linear mile. The Great Trigonometrical stations of Akbarpur, Nandi, and Bhatauli were connected with the work. The mean errors so disclosed being 1·2, and 3·4 feet per mile.

212. *Town surveys.*—The traverse section has carried out the following town surveys for municipalities during the year:—

(*i*) The survey on the scale of 200 feet to one inch of the extension of the civil station of Allahabad (2·16 square miles).

(*ii*) The survey on the scale of 64 inches to one mile of—

Háthras city	3·21	square	miles.
Koil city	4·27	„	„
Sikandra Rao city	0·88	„	„
Atrauli city	0·99	„	„
Kosi city	0·70	„	„
TOTAL	10·05	square	miles.

In Koil, Háthras, Atrauli, and Sikandra Rao, the survey was a very detailed one, the interior limits of each house being shown. In Kosi and Allahabad, only the exterior limits of buildings were surveyed. The cost-rate of the former surveys works out to R1,291-14-5 per square mile, that of Kosi to R910, and that of Allahabad Civil Station to R521-14-5. The work, which was based on a thorough network of theodolite traverses, was checked by an average of 8·9 linear miles and 14·2 acres of check survey per square mile.

213. *Road surveys.*—Boundary charts for the Public Works Department on the scale of 64 inches to the mile, shewing all adjacent detail, were prepared by plane-table traverse of 1113·09 linear miles of first class roads in districts Etah, Agra, Muttra, Aligarh, Bulandshahr, and Meerut. The cost-rate works out to R8-14-5 per linear mile. As a check upon the work 99·80 linear miles were re-surveyed independently. In addition to the above the theodolite traverse survey of 100·48 linear miles of the first class roads in Jálaun, begun last year under the former method of road survey, was completed, at a cost of R6-13-2 per linear mile.

214. *Drawing office.*—This office, located at Naini Tál, has been moved during the year into new quarters, which are more suitable in every way than the small bungalow it previously occupied. Under Mr. J. Kennedy, the officer in charge, eleven standard sheets, including areas in districts Sháhjahánpur, Bareilly, Pilibhít, and Kheri, have been completed and submitted for publication. Twenty-five standard sheets, two district maps, and ten traverse charts are in various stages of progress. One sub-surveyor was employed towards the end of the field season on a topographical survey of the Jumna river bed in Meerut district, as the cadastral material available was found not of sufficient topographical value to allow of its being used *in* compiling the standard sheets. Thirty-four square miles have been surveyed in this manner, on the scale of two inches to one mile, and the fair mapping of the standard sheet concerned has been completed. The drawing office was instituted in 1898 to compile the material resulting from cadastral surveys, five seasons after the modern cadastral surveys had begun. At that time the annual cadastral outturn was very great, no less than seven districts being under survey at one time. There is, in consequence, a mass of cadastral material available, with which the present strength of the office will take some years to cope.

215. The programme for the next field season is as follows:—

Topographical surveys.—The completion of the survey on the scale of 2 inches to the mile of the Jumna river bed in district Meerut, and the topographical revision of portions of Bulandshahr district falling in standard sheets 8, 19, and 32, for which no modern cadastral material is available.

Traverse surveys.—The traverse of 270 square miles in Moradabad district, and the traverse in advance of about 270 linear miles of main circuits along the high banks of the Ganges in the same district.

Cadastral surveys.—The survey and preparation of preliminary records-of-rights of 390 square miles in the Moradabad, Thákurdwára, and Amroha *tahsils*, and the correction of maps and records in 60 square miles in the sandy tracts of Amroha *tahsil* in the Moradabad district. The correction of maps and partial preparation of records of about 789 square miles in *tahsils* Bánda, and Pailáni of Bánda district. The correction of maps and partial preparation of records of about 607 square miles in *parganas* Hamírpur, Sumerpur, and Maudha of Hamírpur district.

Town surveys.—The survey on the scale of 64 inches to the mile, with open ground on the scale of 16 inches to one mile, of about 4·1 square miles in the municipalities of Muttra, Brindaban, and Tanda-khas.

Road surveys.—The survey of 1,335 linear miles of first class roads in districts, Muzaffarnagar, Saháranpur, Dehra Dún, Bijnor, Bareilly, Moradabad, Budaun, Pilibhít, Sháhjahánpur, Kheri, Sítapur, Hardoi, Lucknow, Unao, and Naini Tál.

216. During the field season the Superintendent, Captain Coldstream, R.E., inspected the survey offices at Mainpuri, Jálaun, Azamgarh, and Fyzabad, and the traverse office at Aligarh; he also checked the survey and record work in the field in Mainpuri and Jálaun, and the town surveys in Koil and Háthras, and inspected and reported on the condition of the village maps of Lalitpur surveyed in 1894-97. On his rains tour he inspected all survey offices, and visited

Bánda, Hamírpur, and Moradabad, to make arrangements for the work of the next season.

217. The Deputy Surveyor-General inspected the drawing office at Naini Tál in October 1902, and again in June 1903, when he was present at a meeting of the Board of Revenue to discuss the future survey programme and other matters.

BENGAL.

No. 4 Party and 5 Detachments.

218. The traverse and cadastral survey operations in Bengal remained under the supervision of Major R. T. Crichton, I.A., Superintendent of Provincial Surveys, except for a period of nine weeks (7th August to 30th September), when Lieutenant F. C. Hirst, I.A., officiated during Major Crichton's absence on leave. The outturn of work accomplished, *viz.*, 6,884 square miles of traverse, 2,838 square miles of cadastral and 2,620 square miles of record writing is fully up to the programme, and is considerably greater than the outturn of previous years.

Bhágalpur.

219. In this district 572 square miles have been traversed at a cost-rate of ₹26·6 per square mile. The cadastral survey of 1,622 square miles and the record writing of 1,594 square miles has been completed at a cost-rate of ₹132·5 for both cadastral and records. Considering that there are 1,966,842 fields in this area, the cost-rate is satisfactory. The detail survey has been checked by an average of 4·8 linear miles of *partáls* or test surveys to each square mile of detail, and 28·4 per cent of the entries in the records have been checked by the survey staff. The same trouble as reported in last season in connecting on to the previous Srinagar-Baneli survey was experienced and there is now no doubt that the traverse marks of the old survey had been moved at the settlement stage. Consequently in order to fit in the Srinagar-Baneli survey, an expensive overlap detail survey has had to be undertaken. The Nepal-Bhágalpur boundary, as now surveyed, has been compared with the maps of 1882-83, and the result shows the former survey to be wrong along the Tiljúga and Dumrah rivers.

Personnel-Traverse.

Lt. F. C. Hirst, offg. Assistant Superintendent, 1st grade, in charge.

Personnel-Cadastral.

Section I.

Mr. A. W. Smart, Extra Assistant Superintendent, 2nd grade, in charge.
„ O. J. H. Hart, Sub-Assistant Superintendent, 2nd grade.
„ O. E. C. Judd, „ „ „
2 Supervisors. 33 Inspectors. 20 Office establishment. 304 *Amins*. 295 *Moharrirs*, etc.

Section II.

Mr. C. S. Kraal, Extra Assistant Superintendent, 4th grade, in charge.
„ H. W. Biggie, Extra Assistant Superintendent, 6th grade.
„ S. F. Norman, (Jr.) Sub-Assistant Superintendent, 2nd grade, till 4th April.
„ H. A. Hardless, Sub-Assistant Superintendent, 3rd grade, from 21st July.
„ G. Archer, Sub-Assistant Superintendent, 3rd grade.
2 Supervisors. 35 Inspectors. 20 Office establishment. 310 *Amins*. 300 *Moharrirs*, etc.

Backergunge.

220. During the year under report 1,027 square miles have been traversed at a cost-rate of ₹43·6 per square mile. Considering the unhealthiness and water-logged nature of the country, and the high cost of local labour, this rate is fair and cannot be much reduced until programmes of 1,600 square miles per season in compact blocks are sanctioned. The rate is ₹18 per square mile less than last year. This is due to the larger area of the programme. The cadastral survey of 574 square miles and the record writing of 567

Personnel-Traverse.

Mr. C. H. G. Johnson, Extra Assistant Superintendent, 6th grade, in charge.
Mr. P. Kennegy, Sub-Assistant Superintendent, 3rd grade.
28 Sub-Surveyors. 14 Computers, etc.

Personnel-Cadastral.

Mr. N. Bedford, Extra Assistant Superintendent, 5th grade, in charge.
Mr. E. G. Hardinge, Sub-Assistant Superintendent, 1st grade.
Mr. F. W. Marten, „ „ 2nd grade.
2 Supervisors. 20 Office establishment. 46 Inspectors. 420 *Amins*. 420 *Moharrirs*, etc.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEYS IN BENGAL.

1902-03. No. 4 PART.

Reg. No. 945-S. 03.

BENGAL SURVEY.

INDEX TO THE TRAVERSE SURVEY IN BENGAL.

No. 4 PARTY.

Reg. No. 345. S. 03.

square miles have been completed at cost-rates of R114·7 and R53 per square mile, respectively. The reduction in the cadastral rate as compared with that of last season is due to (*a*) introduction of a certain number of experienced foreign *amins;* (*b*) introduction of a new system of contract payments whereby the *amin* has to provide his own coolie labour. The reduction in the cost-rate of record writing is due to the average size of the field being twice that of the foregoing season.

SONTHAL PARGANAS.

221. During the year under report 2,159 square miles have been traversed. Of this, 861 square miles were traversed in detail for subsequent cadastral survey by the settlement authorities, and the balance of 1,298 square miles, is skeleton traversing with a view to fixing the trijunction points in the area surveyed by Mr. Craven. The cost-rates are R28·3 per square mile for the detail *mausawar* traversing and R14·1 for the skeleton traversing. The rate for the *mausawar* traversing is considerably lower than that of last season, but that for trijunction traversing higher, which is accounted for by the fact that the country was jungly and necessitated heavy line clearing work. The traverse survey of the Sonthal Parganas has now been completed except a small area of about 100 square miles in the Ganges *diára* which will be dealt with as the adjoining districts come under survey.

Personnel.

Mr. C. S. Gasper, Extra Assistant Superintendent, 5th grade, in charge.
Mr. P. F. Delaney, Sub-Assistant Superintendent, 2nd grade.
26 Sub-Surveyors, 19 Computers, etc.

RÁNCHI.

222. During the season, 1,001 square miles have been traversed at a cost-rate of R28·9 per square mile, which is a great reduction on last season's rates. The major portion of the area traversed is hilly, but not nearly so unhealthy as last season's area, which accounts principally for the reduction in cost-rates. During the season experiments were in progress with a view to finding a simple and expeditious method of checking measurements obtained from the observation to a 10 feet subtense bar. This has been effected by fixing two more discs on the bar 8 feet apart, check observations being taken to the 8 feet base. The cadastral survey covered an area of 616 square miles, of which 437 have also been completed in record writing. Owing to the indifferent quality of the newly trained local establishments, it was found impossible to complete the whole area surveyed in record writing as well, but no scattered arrears of work have been left, and the record writing will be brought up to date with the detail survey next season. The cost-rates are R61·7 and 32·3 for detail survey and records, respectively. The low rate for detail survey is due to the provision of free labour; and that of record writing, to the large size of the plot.

Personnel-Traverse.

Mr. T. W. Babonau, Extra Assistant Superintendent, 5th grade, in charge.
Mr. H. A. Hardless, Sub-Assistant Superintendent, 3rd grade, up to 21st July.
29 Sub-Surveyors. 16 Computers, etc.

Personnel-Cadastral.

Mr. W. Skilling, Extra Assistant Superintendent, 5th grade, in charge.
Mr. J. C. C. Lears, Sub-Assistant Superintendent, 2nd grade.
Mr. A. B. Smart (Junior), Sub-Assistant Superintendent, 3rd grade, to 15th May.
1 Supervisor from 4th May. 32 Inspectors. 316 *Amins*, etc.

HAZÁRIBÁGH.

223. The traverse survey of the Kodarma Government Estate comprising 120 square miles has been accomplished at a cost-rate of R35 per square mile.

Personnel.

Same as Ránchi Traverse.

MONGHYR.

224. Two small Government estates have been cadastrally surveyed, and records written, in continuation of the operations of last season. As these estates only total about 100 acres, and are formed of scattered blocks of land no traverse survey was done.

Personnel.

Same as Bhágalpur Traverse.

PURNEA.

225. The traverse survey of 1,189 square miles has been carried out at a cost-rate of ₹24·3. This is the lowest cost-rate reached as yet in Bengal and is due to unusually favourable conditions, *i.e.*, large and compact programme, large average size of village, healthy tract of country, and also to some extent to a new system of contract payments for field work and for a part of the computing work, which has been tried with considerable success in a part of this area.

Personnel.
Same as Bhágalpur Traverse.

RANGPUR.

226. The traverse survey of 88 square miles of the Cooch Behar estates has been completed at a cost-rate of ₹57·3 per square mile. The high rate is due to the small and detached area and also to its very scattered nature.

Personnel.
Same as Bhágalpur Traverse.

MIDNAPORE.

227. The traverse survey of 655 square miles, comprising the Májnamútha, Jalamútha and other estates, has been accomplished at a cost-rate of ₹38·5 per square mile. An area of 35 square miles only remains to complete these estates, and this will be attended to early next season. The cost-rate, considering the very small average size of the village in the area traversed, is not high.

Personnel.
Same as Backergunge Traverse.

MISCELLANEOUS SURVEYS.

228. An area of 21 square miles in *pargana* Harwat of the Purnea district has been traversed, cadastrally surveyed, and completed in records by the Bihar traverse and cadastral sections, at cost-rates of ₹29·8, ₹50 and ₹55, respectively. A number of minor surveys in connection with the relaying of old boundaries in the Monghyr and Shahabad districts have been undertaken by the Bihar traverse section. The area of all these minor surveys is 30 square miles, and in each case the expenditure is met by deposits made by the applicants. Large scale surveys of the Bhágalpur and Roserha municipalities are also in progress, the expenditure being met by the municipalities concerned.

CALCUTTA SUBURBS SURVEY.

229. During the year the Bengal Government requested that a large scale survey of the added area of Calcutta might be undertaken. As no survey officer could be spared from the existing staff employed on Bengal Provincial Surveys, and the Surveyor-General could not provide any more, it was agreed that the work be entrusted to Mr. R. B. Smart, a retired officer of the department, under the supervision of the Superintendent of Provincial Surveys, Bengal. The area to be dealt with is 12 square miles. The work started in the middle of February and during the year the 12 square miles have been traversed (further sub-traverses will be necessary as the detail survey proceeds) and 3 square miles have been surveyed in detail on the scale of 50 feet to the inch (the same scale as that of the Calcutta survey). A certain amount of the record writing has also been completed, but considering the present incomplete state of the work, no attempt to calculate the cost-rates has been made.

BENGAL DRAWING OFFICE.

230. There are now, excluding the supervising or general section, 6 different sections in the Bengal drawing office, *viz.*, (*a*) Standard and district mapping, (*b*) Bihar *badars*, (*c*) Orissa *badars*, (*d*) *Thána* mapping, (*e*) Reproduction of village maps, and (*f*) Map record.

Personnel.
Mr. E. F. Berkeley, Extra Assistant Superintendent, 5th grade, in charge.
Mr. A. B. Smart (Junior), Sub-Assistant Superintendent, 3rd grade, from 21st May.

Reg. No. 967-S. 03.

INDEX TO THE SURVEY OPERATIONS IN BURMA NORTH OF LAT. 18°
REFERENCES.
Previously Surveyed on Scale 16" = 1 Mile
Do. do. 8" = 1 Mile
Do. do. 4" = 1 Mile
Do. Traversed
Surveyed during Season 1902-03 on Scale 16" = 1 Mile
Do. do. do. 4" = 1 Mile
Traversed do.
Revenue Survey Revised
Sheets Published
Provinces Boundary
Districts
NOTES.
The numerals 197, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.
The names of Towns surveyed on large Scales are underlined thus MANDALAY.
Scale of Miles.
40 20 0 40
MYITKYINA
KATHA
KINDAT
MOGOK
LASHIO
KYAUKPYU
THAYETMYO
PAKOKKU
MAGWE
MINBU
PAKHOKKU
Kengtung
Mong Hsat
Mong Pai
Loilem
Kyaingtong
Hsipaw
Tawngpeng
Mong Nai
Mong Hkam
Kyaukme
Mong Yai
Mong Kung
Kyaingtong
Mong Hsu
Mong Yawng
Mong Hsaing
Mong Pawn
Mong Hsu
Mong Hsat

231. During the year the standard mapping section has been considerably augmented to permit of the bringing up of arrears and of keeping pace with the large increase of outturn of the field parties. The section now comprises 24 draftsmen, computers and typers. Of the 32 standard sheets of Orissa, 27 have been revised during the year under report and 23 sent in for publication. Thus, including previous totals there only remain now 4 sheets of Orissa for publication. Out of the 8 standard sheets of Bihar (excluding Darbhanga), 7 have now been completed and sent in for publication. The standard mapping of the Darbhanga district is proceeding satisfactorily and a start is about to be made in that of Backergunge. The standard maps of Chittagong have been unavoidably delayed owing to the difficulties in incorporating old and indifferent material. The compilation of the four sections of the district map of Muzaffarpur on the ½-inch scale for reduction to the ¼-inch, has been in hand, and a commencement has been made with that of Balasore, both these should be ready by April 1904.

232. In the *thána* mapping section satisfactory progress has been made. Of the 24 *thánas* of Orissa, 9 now remain for publication, and of the 29 of Bihar only 2 remain for publication. During the year an experiment to reproduce *thána* maps by the Vandyke process has proved successful, and 100 copies of a *thána* map, including cost of compilation of same, are now provided at a cost of under ₹30 as against ₹160 of former years.

233. In the village map reproduction section a very large increase of plant and establishment has been sanctioned. During the year, 5,916 sheets of Orissa have been traced, 5,067 examined and 5,300 reproduced. The Orissa work is practically completed, as is also that of Chittagong, and a start has been made with Sáran. During the year, 60,778 copies of village maps have been issued to the Collectors of different districts. The average cost of a copy of a village map is now about 6 annas, inclusive of all supervision charges, but this rate will shortly be materially lowered as experiments conducted with a view to finding a paper sufficiently tough to stand field work and at the same time transparent enough to allow of direct reproduction, have been completely successful. In future sheets can be reproduced without the expense of preparing and examining the intermediate trace, and as the process will be purely mechanical, the reproduced copies can be stamped as certified copies, which will largely increase the demand. The future cost of reproduction of a village map will be about 3 annas (with an increased demand, even less) and if a small profit is made on each, and credited against the cost of the survey and settlement, the cost-rates will be materially lowered. Owing to the decision that each Local Government should take over the custody of its original cadastral maps, a new map record section has been added to the Bengal drawing office. Racks have been built to provide accommodation for the requirements of the next 10 years, and a small establishment provided.

234. Major R. T. Crichton, Superintendent of Provincial Surveys, inspected each section of the Bengal surveys in the field on an average of 3 times, and several also during recess. Lieutenant F. C. Hirst also inspected the sections during recess while Major Crichton was on leave.

235. The Deputy Surveyor-General inspected the recess office of the two Bihar sections at Dinapore, and visited the Bengal drawing office at frequent intervals throughout the year.

UPPER AND LOWER BURMA.

No. 7 Party.

Personnel.

Major G. B. Hodgson, I. A., Superintendent, 1st grade, in charge from 29th October 1902 to 30th April 1903.

Lieutenant C. P. Gunter, R.E., Officiating Deputy Superintendent, 2nd grade, in charge from 1st to 28th October 1902 and from 1st May to 21st June 1903.

Mr. J. S. Swiney, Extra Assistant Superintendent, 2nd grade, in charge from 22nd June 1903.

Mr. O. D. Smart, Extra Assistant Superintendent, 4th grade.

„ C. G. Lee „ „ 5th „

Babu Abinash Chunder Bose, Sub-Assistant Superintendent, 1st grade.

Babu Jagdamba Prasad „ „ 1st grade.

Mr. W. E. S. Swiney „ „ 3rd grade.

51 Surveyors, Sub-Surveyors, Computers, etc., and 3 Writers.

236. The outturn of work for the season is as follows:—

Locale.	Square miles.	
	Traversing.	Cadastral Survey.
Upper Burma.		
Pakôkku town (completing the town)	4	3
Pakôkku district	455	603
Shwebo district	302	...
Lower Burma.		
Kyaukpyu district (completing the district)	42	74
Totals	803	680

The area traversed in Shwebo is in excess of the proposed programme owing to the desire of completing as much of this district as possible, the local settlement having already commenced. In Kyaukpyu the area surveyed is cultivated land only, and proved to be much less than the estimate which included jungle.

237. During the field season the sections employed in Upper Burma enjoyed good health, except during the month of May in the Shwebo district when five men died from dysentery. In Lower Burma, as was expected, the men suffered a great deal from fever throughout the field season; there were, however, no deaths, but four men were invalided to India.

238. The cost-rates for the season are—

Upper Burma.

	R
Traverse survey—	
Pakôkku district, per square mile	61
Shwebo district, „ „ „	85
Cadastral survey—	
Pakkôku district, per square mile	117

Lower Burma.

	R
Traverse survey, per square mile	438
Cadastral survey, „ „ „	536

In Upper Burma the cost of traversing Pakôkku district is R4 more than it was last year, due entirely to the nature of the work being more difficult and the area less. In Shwebo, as was expected, the cost is much greater due to the area surveyed being scattered in small blocks throughout the entire length of the district, and to the loss of time entailed in opening up old traverse stations. The rate of the cadastral survey is much the same as last year; this is satisfactory, as the average area of fields is smaller, and the proportion of jungle to cultivation less. In Lower Burma the cost of both traversing and cadastral survey is very high, due entirely to the very small areas surveyed, the scattered nature of the work, and the enormous difficulties encountered in the district; the expenditure on transport (water carriage being the only means of conveyance of men and baggage) almost alone accounts for the difference between the cost-rates in Kyaukpyu and in Sandoway last year.

Upper Burma.

239. The traverse survey was in charge of Lieutenant C. P. Gunter, R.E., assisted by Mr. C. G. Lee, and towards the end of the field season by Babu Jagdamba Prasad. The subordinate establishment consisted of ten traverse surveyors and eight computers. In the Pakôkku district the traverse survey was in continuation of last season's work, and situated in the Myaing township. In the Shwebo district the traverse work consisted of the completion of small blocks of country, scattered throughout the district east of the railway line, which had been omitted by the survey of 1892-94.

240. The country traversed in the Myaing township is hilly and deeply indented with ravines, about two-thirds of it being covered with scrub-jungle, water being scarce everywhere. In the Shwebo district the areas traversed comprised hilly country, cut up by deep ravines and three-fourths of it covered with thick bamboo and scrub-jungle. The results of this season's work show a great improvement on last year's. The demarcation in the Myaing township was good and in Shwebo as good as can be expected in such wild country. The demarcation maps were excellent. The traverse section took the field on the 16th October, and returned to recess quarters at Mandalay on the 1st June. The theodolite stations were marked with galvanized iron cylinders. The angular work was checked by observations for azimuths at 38 stations in Pakôkku and at six stations in Shwebo. Double chaining was employed on main and subcircuits and in the town work only. Connections were made to two intersected points of the Great Trigonometrical Survey, *Pagodas* 63 and 64, from last season's traverse work. The average error in chaining in the Pakôkku district works out to 0·22 links per mille; the error in the Shwebo district necessarily involves the errors of the former surveys and is of no value here; all the circuits closed satisfactorily. All the computations have been completed as far as is possible.

241. Mr. J. S. Swiney was in charge of the cadastral section. He had two assistants, Babu Abinash Chunder Bose and Mr. W. S. Swiney. The survey was tested by 725 linear miles of check lines, giving an average of 3 linear miles per square mile actually surveyed. The cadastral work in Pakôkku was started on 11th November 1902, and was completed on 11th June 1903. The average number of *amins* was 55 employed for an average of six months. The detail survey was mapped on 680 sheets on the 16-inch scale. Of the field sheets 153 were mapped on bank-post paper by the field surveyors, and these original sheets have been sent to Calcutta for reproduction by the Vandyke process, and it is hoped that they will prove a success, as the cost and trouble of making traces will be saved by this means.

242. During the recess the 16-inch field sheets were all completed, and traces have been sent to Calcutta for reproduction by the Vandyke process. In addition to this, the traces of 703 16-inch field sheets of previous season's work, and work revised by local authorities, have been completed and sent to Calcutta for reproduction. Miscellaneous work has also been done for the Settlement Department. Standard sheet 151 has been completed to date on the 2-inch scale, and will be sent to No. 10 Party for their use. Standard sheets 102, 103, 104, 105, 147 and 148 have been completed and sent to Calcutta.

243. The programme for next season consists of the traverse survey of 220 square miles in the Shwebo district, 450 square miles in the Pakôkku district, the cadastral survey of 520 square miles in the Shwebo district, and 280 square miles of Pakôkku district.

LOWER BURMA.

244. Mr. O. D. Smart was in charge of the survey work in Lower Burma, both traverse and cadastral. He was assisted during the field season by Babu Jagdamba Prasad. The subordinate establishment consisted of six traverse surveyors, 34 field surveyors and 13 office hands. The work commenced in Kyaukpyu on 14th November 1902 and closed on 24th April 1903. This year's work completes the Kyaukpyu district, and also the programme as laid down by the Burma Government for Lower Burma. All the theodolite stations were marked with galvanized iron cylinders. The angular work was checked by observations for azimuth at 64 stations and the angular error is 1 minute in every 15 angles on village circuits. Double chaining was employed throughout, as there were no main circuits owing to the scattered nature of the work. The traversing was connected in three separate blocks to three hill stations of the topographical survey, and the average error in chaining works out to 0·3 links per mille. All the circuits closed satisfactorily. The 148 *kwins* surveyed in detail were scattered along a sea coast line of 100 linear miles. The detail survey was checked by 120 linear miles of check lines, giving an average of 1·6 linear miles per square mile of area actually surveyed, and was mapped on 323 sheets on the 16-inch scale.

245. The country surveyed in Kyaukpyu is densely wooded and covered with mangrove jungle, and cut up every few miles by huge arms of the sea. Only the cultivated areas were surveyed in detail.

246. The 16-inch cadastral sheets were all completed during the recess, and traces of all have been prepared and sent to Calcutta for reproduction by the Vandyke process. The area surveyed in Kyaukpyu being so small and scattered, 2-inch reductions have not been made for the local authorities.

247. The Government of Burma have asked for the survey of the added area of Rangoon town for the municipality on the scale of 100 feet to the inch covering an area of about 15½ square miles, but since this area has not yet been demarcated, it is doubtful if the work can be commenced next field season.

GODÁVARI DETACHMENT.

248. On 13th May 1901, the Government of Madras in their No. 405 I to the Government of India, applied for the topographical survey of the Godávari delta embracing an area of about 300 square miles on the same scale as the village maps in the vicinity, *viz.*: 16 inches = 1 mile, for the purposes of Madras Act VI of 1884. A number of permanent marks along both banks of the river were also required to be fixed, and built. For this latter purpose a detachment from Nos. 9 and 19 Forest parties under Mr. Sheehan was deputed to undertake the triangulation during season 1901-02, when 109 permanent stations were built, and 39 intersected points fixed. In November, 1902, it was ascertained from the Chief Engineer for Irrigation, Madras, and from information derived from the Madras Conservancy Act that of the 300 square miles, about 180 square miles were required to be surveyed cadastrally with a record of rights, and the remaining 120 miles only, consisting of water and sand in the river bed, were for topographical survey. A representation was accordingly made to the Madras Government on 28th November 1902, and early instructions solicited as to whether under the circumstances the work was to proceed. In the meanwhile a small establishment of traversers were sent into the field on 29th November under Babu Nilmoni Chatterjee, Extra Assistant Superintendent, to provide a sufficiency of data for the detail surveyors, and as no *amins* or inspectors were available locally, they were engaged in the United Provinces, and kept on a small retaining fee pending the receipt of final orders from the Madras Government, which, however, notwithstanding repeated references, were not received till the 9th March 1903. Thus 3½ months of the best part of the field season were lost.

Personnel.
Babu Nilmoni Chatterji, Extra Assistant Superintendent, 6th grade, in charge up to 9th April 1903.
Mr. S. F. Norman (Jr.) Sub-Assistant Superintendent, 2nd grade, in charge from 10th April 1903.
7 Sub-Surveyors, etc.

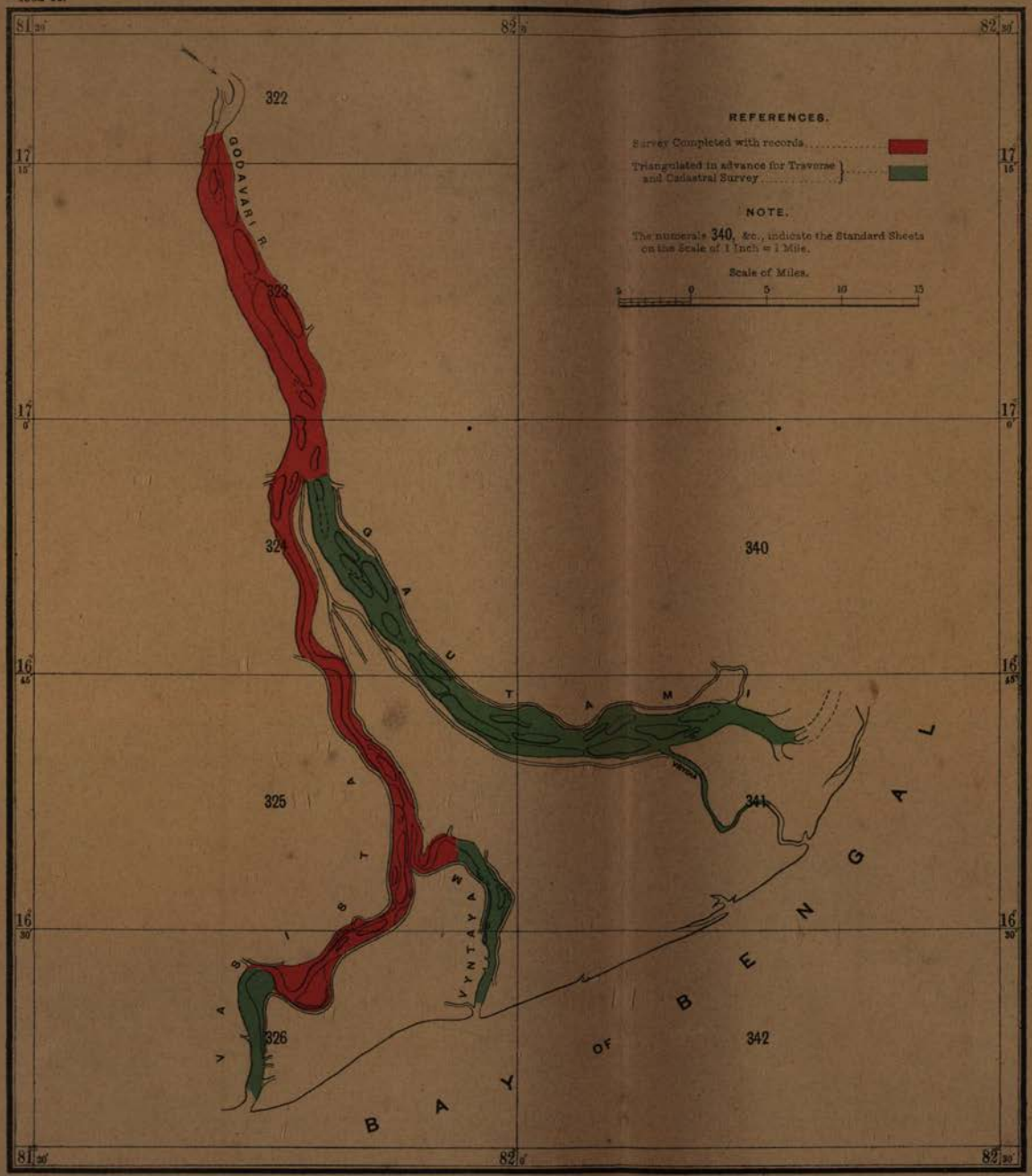
249. The establishment engaged on the work was formed into a separate detachment from 1st December 1902 and placed under the administrative control of the Deputy Surveyor-General from 17th idem. Babu Nilmoni Chatterji held charge of the detachment till the 9th April, when falling ill, was obliged to apply for leave on medical certificate, and was relieved of his duties by Mr. S. F. Norman, Sub-Assistant Superintendent.

250. The area both traversed and cadastrally surveyed was 131 square miles which included the river from Golavaram to the anicut, a distance of 25 miles, and practically the whole of the western delta (distance 30 miles). The *amins* to take up the detail survey did not arrive till March. The origin of survey is latitude 16°50′ and longitude 81°55′, the traverses being based on the triangulation of the river which was completed the previous year. The traverse stations were marked by pegs, the average number of stations laid down during the year being 12 per square mile. The area was subdivided into 3 river circuits comprising 31 blocks. The chaining proved very well, the error being 5 links in 1,000 chains, the angular error working out to 4 seconds per station. 93 sub-traverses were run and 51 permanent mark stones with a circle and dot chiselled on the flat top, have been embedded along both flood banks of the river at intervals of from 2 to 4 miles by triangulation, ensuring the greatest intervisibility, whilst traverses have also been run con-

MADRAS SURVEY.

INDEX TO THE GODAVARI CADASTRAL SURVEY.

1902-03.



No. 700. S. I.—Nov. 02—500.

Photo. S. I. O., Calcutta.

Reg. No. 960-S. 03

necting the river survey to the fixed points of the Madras Revenue Survey. The outturn in traversing per man per mensem was 28 linear miles of chaining and 151 angles; and in cadastral survey 698·66 acres or 224 fields, the average size of the field being 3·11 acres.

251. The cadastral survey was mapped on 165 sheets on the 16-inch scale, and checked by 89 linear miles of *partáls* by the officer in charge independently, and 153 linear miles by inspectors, or a total of 242 miles of test lines to each square mile of detail survey. No demarcation was carried out, but *lanka* boundaries have been shown on the charts as pointed out by the *kernams*. Only two disputes arose regarding these, one of which is between Government and *samindári* lands.

252. The record writing was done chiefly under the supervision of the village *kernams*, and written up by local men appointed especially for this work; the *amins*, being unacquainted both with the language and the tenure system, simply reading and numbering the charts; next year, however, the Superintendent, Madras Survey, has promised to lend the services of local *amins* thoroughly versed in *khánápuri*, which will not only ensure more correctness in the work, but will, it is expected, greatly reduce the cost of the same. The average outturn in *khánápuri* per man per day was 60 numbers, 25 per cent. of the whole being checked by inspectors. The following statement gives particulars of the work done and cost-rates.

District.	Triangulation during 1901-02.			Traversing. 1902-03.			Cadastral survey and record-of-rights. 1902-03.			
	Blocks.	Square miles.	Cost per square mile.	Blocks.	Square miles.	Cost per square mile.	Blocks.	Square miles.	Fields.	Cost per square mile.
Godávari (river-area under Conservancy Act).	...	300	17	31	131	24	31	131	26,947	119·25

The rate ₹143 per square mile for both traverse and cadastral survey combined is not excessive, taking into consideration the fact that the inspectors and *amins* and tindals had to be imported from the United Provinces, entailing an expenditure of ₹3,500 and the high rate of pay fixed in order to induce them to come. The loss of 3⅓ months of the field season referred to above, also reduced the outturn, which necessarily affects the cost-rate. The cost of the triangulation cannot rightly be included in the expenditure, as a triangulation was not necessary for the cadastral survey, but for laying down permanent marks as explained above. Again, the nature of the country made the supply of boats to the surveyors necessary, and this is a heavy item of expenditure, as is also the high local rate of pay of interpreters for *amins*.

253. The detachment remained out in the field till 4th August to complete the *khánápuri* of the area cadastrally surveyed, and proceeded to recess quarters at Bangalore.

254. The health of the detachment was satisfactory on the whole, two deaths occurred among the cadastral staff, one died of plague.

255. During recess the computations have been completed, the tracing of the field maps will be completed by the end of the recess, as also the areas. The traces are being done on vellum cloth for reproduction by the Vandyke process; the block numbers and also those of adjoining sheets have been printed on the traces, so that no difficulty may be experienced hereafter in fitting them together.

256. The area surveyed being 131 square miles, leaves approximately 169 square miles to be completed. The triangulation of this has been done, the traverse and detail survey remain to be finished next season. If the orders of the Madras Government had been received earlier, there is no doubt the whole area could have been done in one field season, at a much reduced cost-rate.

257. The detachment was inspected by the Deputy Surveyor-General during the field season in May, and by the Chief Engineer accompanied

by the Superintending and Executive Engineers on the 26th June. The latter examined all maps and records and expressed their satisfaction on the work done, and concluded by inspecting the permanent mark stones laid down by triangulation. The detachment was again inspected at Bangalore in August by the Surveyor-General and Deputy Surveyor-General.

ASSAM.

ASSAM DETACHMENT.

258. The detachment continued traverse work under Mr. T. Shaw who was in charge throughout the year. Mr. C. O'Donel was on deputation under the District Judge of Sylhet from the 28th October 1902 till the 11th July 1903 as a Commissioner in a boundary dispute case between Government and the Hill Tippera State.

Personnel.

Mr. T. Shaw, Extra Assistant Superintendent, 2nd grade, in charge.
„ C. O'Donel, Sub-Assistant Superintendent, 1st grade.
8 Sub-Surveyors, 3 Computers, 4 Draftsmen, 1 Writer, 1 Land Records Clerk.

259. The actual areas traversed are shown in the following statement:—

District.	Traverse for detail survey on scale 16"=1 Mile.		Traverse for skeleton survey of Tea grants.		Total.
	Villages.	Square miles.	Grants.	Square miles.	Square miles.
Kámrúp	79	96	...	...	96
Darrang	27	21	42	19	40
Nowgong	...	...	10	25	25
Sibságar	11	12	9	20	32
Lakhimpur	...	...	85	81	81
Total .	117	129	146	145	274

Out of 6,440 stations at which the sub-surveyors set up their theodolites—

459 were on *pakka* pillars.
519 „ „ old stone prisms.
158 „ „ rough stones.
5,304 „ „ wooden pegs.

Most of the wooden pegs have had mounds erected five feet north of them. The traverse stations have been connected with former traverse surveys and so their geographical positions are ascertained for projection on the standard maps. The season's work involved 860·85 linear miles of new chain measurements and observations for azimuth at 89 stations.

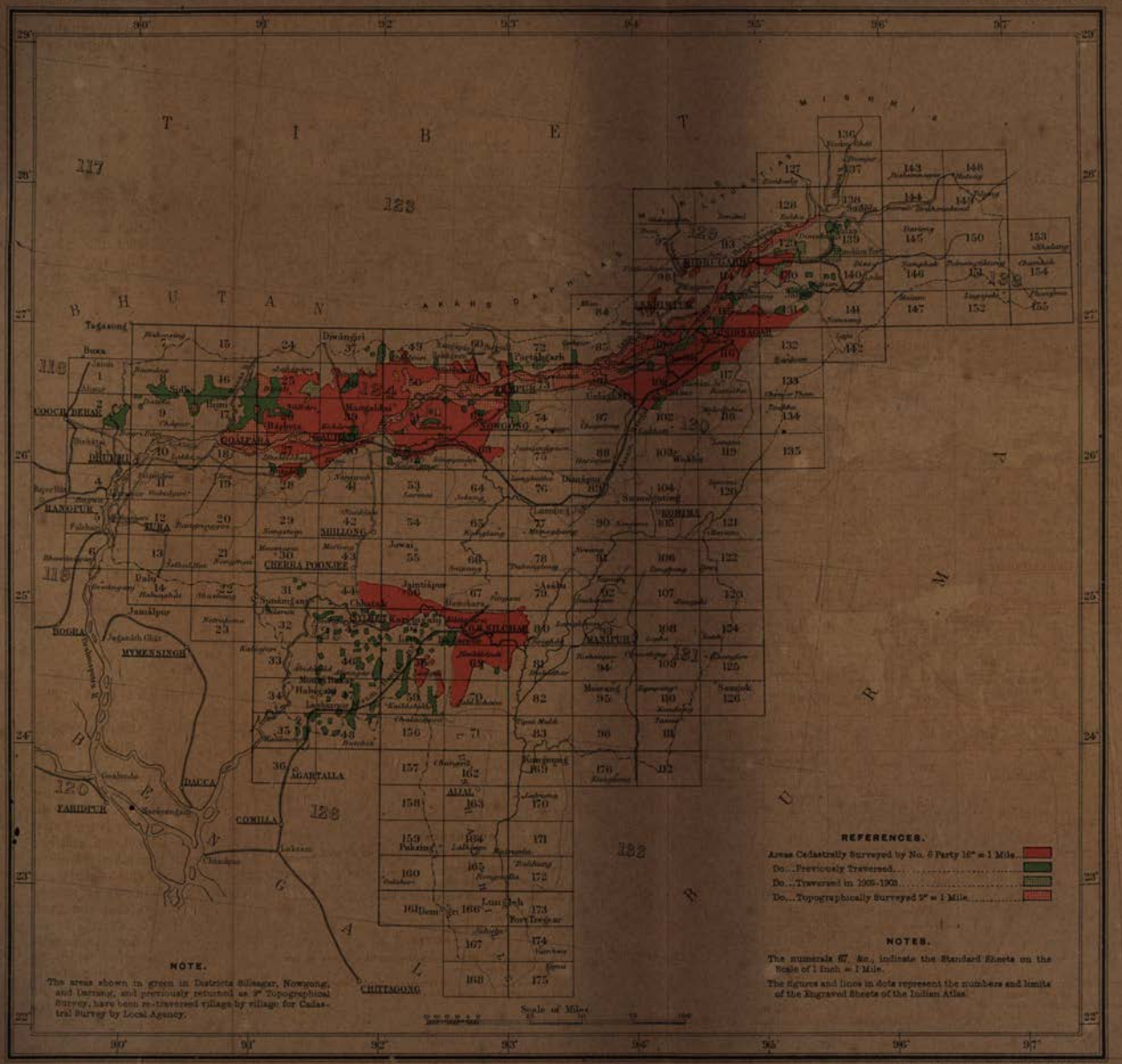
260. The area of 96 square miles in district Kámrúp was traversed in order to supply the Settlement Department with fixed points for the purpose of bringing up to date the cadastral maps of *pargana* Barama surveyed by No. 6 Party in 1883-85. During the cadastral survey of part of district Kámrúp by No. 6 Party only trijunction points were permanently marked, all other theodolite stations being left unmarked. As extensive changes were found to have taken place in the fields originally mapped, the Settlement Department was unable to carry out the alterations properly without the help of fixed points, and it was to supply these and to mark the new points on the printed cadastral maps that the fresh traverse survey of these 96 square miles was undertaken.

261. The cost-rates for traverse survey vary from Rs. 20 per square mile in district Kámrúp where only villages in one ring fence were traversed, to Rs. 83 in district Lakhimpur where only tea grants were dealt with. The high cost-rate for tea grants is not due solely to the scattered nature of the work nor to the inclusion of cost of connecting traverses, but principally to the want of co-

ASSAM SURVEY.

INDEX TO RECENT CADASTRAL, TRAVERSE, & TOPOGL. SURVEYS IN THE BRAHMAPUTRA & SURMA VALLEYS.

1902-03. ASSAM DETACHMENT.



NOTE.

The areas shown in green in Districts Sibsagar, Nowgong, and Lakhimpur, and previously returned as 2" Topographical Survey, have been re-traversed village by village for Cadastral Survey by Local Agency.

REFERENCES.

Areas Cadastrally Surveyed by No. 6 Party 16" = 1 Mile.
Do. ...Previously Traversed.
Do. ...Traversed in 1901-1903.
Do. ...Topographically Surveyed 2" = 1 Mile.

NOTES.

The numerals 67, &c., indicate the Standard Sheets on the Scale of 1 Inch = 1 Mile.

The figures and lines in dots represent the numbers and limits of the Engraved Sheets of the Indian Atlas.

Published under the direction of Major F. B. Longe, R.E., *Officiating Surveyor General of India*

Engraved at the Survey of India Office, Calcutta, 1903

Litho. S. I. O., Calcutta

operation on the part of tea grant managers. The cost-rates per square mile by districts and class of work are, as follows:—

District.	Villages.	Grants.
	₹	₹
Kámrúp	20	...
Darrang	55	54
Nowgong	...	78
Sibságar	63	62
Lakhimpur	...	83

Taken as a whole, the cost-rate per square mile of traversing was Rs. 55. This includes the cost of measurement of offsets to the boundaries of 145 square miles of tea grants.

262. In district Cachar a sum of ₹225-13-8 was expended without any traverse survey being done. A sub-surveyor with squad was sent to Cachar to undertake the traverse survey of about 3 square miles of disforested area which the local authorities wish to lease out to cultivators. When the surveyor reached Silchar the country was found to be flooded and the traverse survey had consequently to be abandoned till next field season. Timely information by the local authorities concerned would have prevented this mishap and waste of money. In future the employment of professional surveyors on such very small and detached operations is not to be recommended.

263. No topographical surveys were undertaken in the Province during the year under report.

264. The preparation of standard maps was continued in the drawing office, but, owing to the smallness of the establishment, and the continued lack of supervision due to Mr. Shaw's absence from Shillong for seven months of the year, no maps were submitted for publication. Arrangements have been made to strengthen the drawing establishment considerably as well as for the continuous residence at Shillong of an officer of the provincial service to supervise the drawing office. Greater efficiency will consequently result and the publication of maps may be expected early in the ensuing year.

265. A class for training local officers in practical field surveying was held at Palásbári in district Kámrúp for five weeks in February and March 1903, during which time Mr. Shaw instructed one Extra Assistant Commissioner and one Sub-Deputy Collector. There were to have been eight officers present at the class but six were not able to attend owing to the urgency of revenue collection at the time. Mr. Shaw also conducted an examination for first class certificates at the Gauháti survey school. Mr. Shaw examined the maps and records of the Land Records Department in districts Darrang, Kámrúp, Sibságar and Lakhimpur, and completed a revised demarcation of the coal mines at Cherra Poonjee.

266. The proposed programme for next field season is as follows:—

District.	Traversing for cadastral survey by local Agency.	Traversing of tea grants.
	Square miles.	Square miles.
Kámrúp	15	16
Darrang	19	14
Nowgong	...	19
Sibságar	...	9
Lakhimpur	...	165
TOTAL	34	223

Also the demarcation of a boundary between *pargana* Habraghát, and the Kámrúp district and other miscellaneous surveys.

267. The Deputy Surveyor-General inspected the office at the end of September 1903 and looked carefully into the state of each map. He also brought forward certain proposals before the Chief Commissioner for placing the detachment on the same footing as the Central Provinces detachment as regards control and audit of pay.

GEODETIC

ASTRONOMICAL LATITUDES.

NOS. 22 AND 23 PARTIES.

268. During the season 1902-03, these parties were combined and employed under Lieutenant H. McC. Cowie, R.E., on Latitude operations on the southern portion of the Budhon Meridional series, between the parallels of 24° 30′ and 27° 0′ North Latitude; on the Calcutta Longitudinal series at stations about 79° E. Longitude, and at one station, Birond of the N. E. Longitudinal series.

Personnel.

Lieutenant H. M. Cowie, R.E., Officiating Deputy Superintendent, 2nd grade, in charge.
Babu Hanuman Prasad, Sub-Assistant Superintendent, 1st grade.
4 Sub-Surveyors and Computers.

269. The instrument used was Troughton and Simms' Zenith Telescope No. 1, furnished with two levels.

Talcott's method of observation was employed.

270. The following table gives the results of the season's work:—

Table giving the final values for Latitude and the apparent deflection of the plumb-line at each station.

Series.	Stations.	Height above M.S.L.	East Long.	Astronomical Latitude =O.	P. E.	Geodetic Latitude =C.	Apparent deflection of plumb-line =O—C.
			° ′	° ′ ″	″	° ′ ″	″
Budhon Meridional series.	Gúrmi	575	78 33	26 36 5·97	±0·049	26 36 3·63	+ 2·34
	Majhár	1028	78 31	26 6 20·30	±0·039	26 6 17·00	+ 3·30
	Algi	1154	78 24	25 29 48·15	±0·038	25 29 46·20	+ 1·95
	Andhiári	1630	78 16	24 41 11·29	±0·026	24 41 6·77	+ 4·52
	Dargawa	1452	79 4	24 37 17·31	±0·040	24 37 13·21	+ 4·10
Calcutta Longitudinal series.	Budhon	1867	78 34	24 5 8·99	±0·034	24 5 8·41	+ 0·58
	Saugor	2033	78 49	23 49 48·71	±0·043	23 49 48·07	+ 0·64
	Náharmau	2240	78 52	23 30 13·11	±0·049	23 30 18·14	− 5·03
N. E. Longl. series.	Birond	6967	79 45	29 14 29·71	±0·053	29 15 14·15	−44·44

The apparent deflections of the plumb-line, deduced from the latitude results, seem to indicate that the northern limit of the area of positive deflections is trending from south-west to north-east between the meridians of 77° and 80°. Between these meridians the line of maximum positive deflection appears also to run to the north-east.

The results also seem to show that Rangir (Lat. 24° 0′ Long. 79° 28′) is similar to Pahargarh (Lat. 24° 56′ Long. 77° 44′) in exhibiting an isolated negative deflection in a locality where the deflections are generally positive.

The result given by the observations at Birond falls into line with those already obtained round Darjeeling and Mussooree and seems to indicate that the large northerly deflections found in these two localities are not abnormal, and that similar northerly deflections will be met with all along the outer ranges of the hills.

The minor investigations carried out during the season were in connection, for the most part, with the micrometer and the systematic and periodic errors of the screw. Corrections for these, however, have not as yet been introduced into the computations.

271. The parties were inspected by the Superintendent, Trigonometrical Surveys, in June 1903.

SECTION

of the

EARTH'S CRUST IN UPPER INDIA

on the meridian of 77° 30'

Fig. 1.

Showing a true section of the surface of India as determined by levelling.

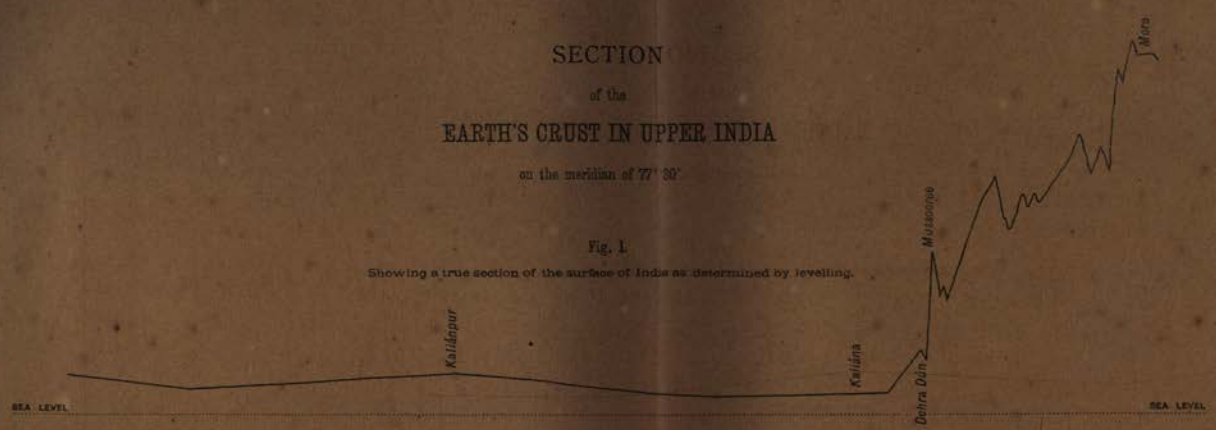
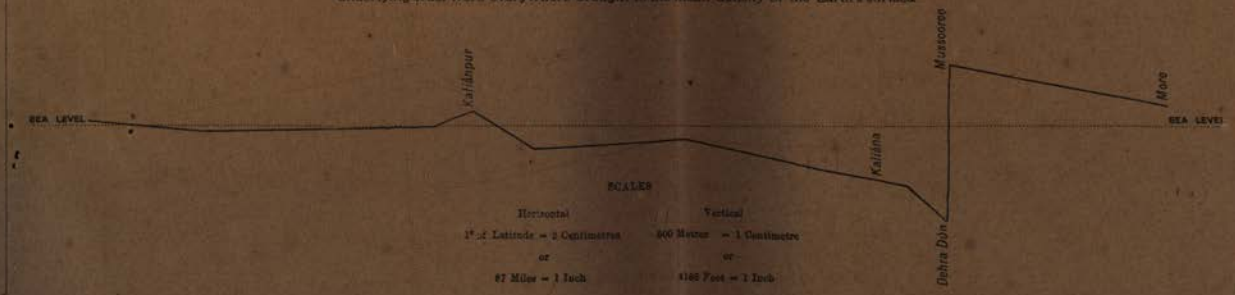


Fig. 2.

Section derived from Pendulum Observations showing the surface of India as it would be, if the underlying crust were everywhere brought to the mean density of the Earth's surface.



SCALES

Horizontal	Vertical
1° of Latitude = 2 Centimetres	500 Metres = 1 Centimetre
or	or
87 Miles = 1 Inch	4166 Feet = 1 Inch

Reg. No. 620-S. 04.

TIDAL AND LEVELLING OPERATIONS.

No. 25 Party.

Personnel.

Captain H. H. Turner, R.E., Officiating Deputy Superintendent, 1st grade, in charge from 16th April 1903.
Lieutenant F. B. Tillard, R.E., Officiating Assistant Superintendent, 1st grade, in charge from 23rd October 1902 to 15th April 1903.
Mr. E. J. Connor, Extra Deputy Superintendent, 2nd grade, in charge up to 22nd October 1902.
Mr. J. P. Barker, Extra Assistant Superintendent, 5th grade.
" H. G. Shaw, " " " 6th "
" E. H. Corridon Sub-Assistant " 1st. "
Munshi Syed Zille Hasnain, Sub-Assistant Superintendent, 2nd grade.
21. Surveyors, Computers, etc.

272. Mr. E. J. Connor held charge of the party until the 22nd October 1902 when Lieutenant F. B. Tillard, R.E., took over and held charge until 15th April when he was relieved by Captain H. H. Turner, R.E., who continued in charge for the remainder of the year.

Tidal Operations.

273. Observations were being taken at the following tidal stations at the commencement of the survey year:—

	Stations. (Those shown in italics are *permanent*.)	Automatic or Personal observations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.	Remarks.
1	Suez	Automatic	1897	Still working	6	To be closed.
2	Perim	"	1898	1902	5	Closed on 25th February 1903.
3	*Aden*	"	1879	Still working	23	
4	*Kurrachee*	"	1881	"	22	
5	Porbandar	"	1898	1902	5	Closed.
6	Port Albert Victor (Kathiawader)	"	1900	Still working	3	To be closed.
7	*Bombay* (Apollo Bandar)	"	1878	"	25	
8	Bombay (Prince's Dock)	"	1888	"	15	Property of Port Trust.
9	*Madras*	"	1880 1890 restarted 1895	Still working	10 8 18	
10	*Kidderpore*	"	1881	"	22	
11	Bassein (Burma)	"	1902	"	1	
12	*Rangoon*	"	1880	"	23	
13	*Port Blair*	"	1880	"	23	

274. The 11 tidal observatories now working were inspected during the year, and in addition those at Porbandar and Perim were visited and finally closed. The registrations at all the observatories, except those at Porbandar, have been satisfactory. At Porbandar the communication pipe again became choked with sand.

275. The two following tables show the annual and decadal percentages of the predicted time and height errors of high and low water at open coast and riverain stations.

Percentages of Errors in Predicted Times and Heights at open Coast Stations from Automatic Registrations.

Year.	Number of stations.	In time: Within 15 minutes of actuals. H. W.	In time: Within 15 minutes of actuals. L. W.	In height: Within 8 inches of actuals. H. W.	In height: Within 8 inches of actuals. L. W.	In height: Within 1/8 of mean range at Springs. H. W.	In height: Within 1/8 of mean range at Springs. L. W.
1893	9	73	68	93	98	96	95
1894	10	65	62	95	92	97	95
1895	9	68	65	98	97	94	94
1896	9	71	70	97	97	97	93
1897	8	71	75	96	97	97	97
1898	9	74	70	96	96	95	95
1899	9	74	66	95	95	93	92
1900	11	66	60	93	88	93	89
1901	11	71	60	93	91	93	91
1902	9	76	67	94	95	96	96
Average of 10 years	9	71	66	95	95	95	94

Percentages of Errors in Predicted Times and Heights at Riverain Stations from Automatic Registrations.

Year.	Number of stations.	In time		In Height			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at Springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1893	2	57	57	68	50	89	84
1894	2	56	55	66	42	88	80
1895	2	59	55	74	47	94	84
1896	2	56	55	63	42	87	74
1897	2	59	61	75	57	96	91
1898	2	53	59	71	61	90	91
1899	2	55	59	76	65	95	94
1900	2	59	62	70	57	89	87
1901	2	63	65	70	59	90	92
1902	2	63	54	76	53	96	90
Average of 10 years	2	58	.58	71	53	91	87

276. After a lapse of 30 years, tidal observations will in 1904 be again taken at Okha on the Gulf of Cutch, and the question as to whether the land round the Gulf is gradually rising will be finally settled.

277. The tide predicting machine which till now has been in the charge of Mr. Roberts of the Nautical Almanac Office will at the end of this year be moved to the National Physical Laboratory at Teddington and Dr. Glazebrook will supervise the tide predictions.

Spirit Levelling Operations.

278. The levelling detachment was employed in Burma on two separate lines of levelling.

1. Thazi to Minbu.
2. Sagaing to Tantabin.

It completed 215 miles of double levelling, which included the crossing of the Irrawaddy river from Magwe to Minbu.

The detachment left Dehra Dún on the 14th October 1902 and returned to recess quarters on the 17th May 1903.

During next field season the levelling operations will be continued in Burma, the line Sagaing to Tantabin being continued as far as Myitkina.

MAGNETIC.

No. 26 Party.

279. During the past year satisfactory progress has been made with the work of the magnetic survey, but owing to the non-delivery of certain instruments from England, only four out of the five base stations or fixed observatories are at present in working order.

Personnel.

Captain H. A. D. Fraser, R.E., Officiating Superintendent, 2nd grade, in charge.
Mr. H. P. D. Morton, Sub-Assistant Superintendent, 2nd grade.
Babu Rama Prasad Ray " " 2nd "
Mr. A. M. Talati " " 3rd "
" E. A. Meyer " " 3rd "
8 Observers, Recorders, etc., and 1 Writer.

280. During the field season the officer in charge took observations at four new repeat stations in addition to revisiting the five old ones established last season. He took also comparative observations at the Dehra Dún, Colába and Kodaikánal observatories, and inspected each of the five field detachments.

Of these detachments only two were able to work for a full season, *viz.*, six months, as one of the first three observers trained during the previous year had resigned his appointment. The work done by each detachment was as follows.

281. The first was employed in various parts of the Punjab, partly in revising some of the work of the previous season along the N. W. Railway, and partly in running a line of stations parallel to and west of the Indus, observations being taken at 69 stations. The second detachment worked nearly the whole season in the Rájputána desert, and in many places had considerable difficulties to contend with in obtaining supplies and drinking water. The observer visited 60 new stations and reobserved at five old ones, in every case observing all three elements. The officer in charge of the third detachment, after a preliminary tour in the neighbourhood of Dehra Dún, started for Bombay and traversing the Railway systems in the south of India, observed at 64 stations. The fourth detachment was employed in observing at points on the narrow gauge railway system in the south of India, thirty-two stations being thus completed. Owing to the late appointment of the observer, and the paucity of instruments, the fifth detachment was not able to commence work till late in the season, when observations were taken at 14 stations.

282. Up to the present time observations have been taken at 370 different places in addition to the nine repeat stations, and a considerable proportion of the first year's stations have also been revisited.

283. On returning from the field each observer took a number of comparative observations at Dehra Dún to find the differences between his instruments and the Survey Standards, and then proceeded to recess quarters at Mussooree, where the office opened on the 7th May 1903. The accuracy of the work done during this season leaves little to be desired, and was fully up to the standard laid down. During the recess season all field work was computed and abstracts of the results made, besides which the reduction and tabulation of the Dehra Dún base station records for the year 1902 was completed.

284. The erection of the buildings for the new base station at Barrackpore was not completed till early in July 1903, but by the 10th August the installation of the instruments was satisfactorily completed, and since that date the work has been carried on continuously. The Barrackpore buildings are entirely above ground, and should therefore be free from those troubles inseparable from underground installations, which have caused such serious difficulties both at Dehra Dún and Kodaikánal.

285. There now remains only the Rangoon observatory, the installation at which place will complete the five base stations sanctioned for the survey. The magnetographs were ordered early in 1902, but contrary to expectation they have not yet been received in India, the delay having arisen because the Kew authorities, owing to pressure of other work, have so far been unable to test them.

286. The vertical force instrument for Dehra Dún has also been delayed for the reason above given. Sanction for the purchase of three more of these instruments for use at Barrackpore, Kodaikánal, and Rangoon has been obtained, but they will not be ordered till the set shortly expected for Dehra Dún has been erected and tested. When the four new base stations are supplied with vertical force magnetographs their equipment may be considered complete as far as can be foreseen at present, but until that time the final reduction of the field work now in full progress must be carried out at a considerable disadvantage, as it will rest, as far as the results in vertical force are concerned, solely on the indications of the vertical force magnetograph at Bombay (Colába). This is unfortunate, but under the circumstances was unavoidable.

287. A table showing the approximate preliminary values of the magnetic elements observed during the last field season is printed in the Appendix, together with a reference index map. All stations from 164 onwards are new stations, and the results shown against numbers less than 163 are repetitions of the first season's observations, which were to some extent defective.

288. During the field season 1903-04, there will be five field detachments at work during the whole season. Of these one will be employed in further revision of the first season's work, and in filling up the few gaps remaining in the area west of the line, Bombay to Dehra Dún. Two others will complete the work in the south of India, west and south of the main railway line from Bombay to Madras, and the remaining two will be engaged in traversing the numerous railway lines west of the meridian of Calcutta, which have not hitherto been visited.

The officer in charge will reobserve at the nine existing repeat stations and establish six new ones, thus completing the full number contemplated west of

the meridian of Calcutta. In addition to the above the usual comparative observations will be made at the four existing base stations, and the installation at Rangoon will be effected as soon as the instruments are available.

289. Provision has been made to train another officer in magnetic work, so as to be available during the absence of the present officer in charge of the survey. By the end of the next field season this officer's training will have been completed and the work will no longer be dependent entirely on the continuation in office of one man, as has hitherto been the case.

290. Steps have been taken, in consultation with Sir Arthur Rücker, F.R.S., and other magnetic experts, to settle the main principles on which the final reduction of the field results are to rest, and some progress has already been made in this most important matter.

TABULAR STATEMENTS.

Summary of the outturn of work of the

Scale of Survey.	Number of Party.	Locale of Operations.		Triangulation.					1st Class.			Secondary.			Tertiary.		Spirit-levelling Operations.		
				Instrument used. Diameter in inches.	Area in square miles.	Square miles to each point trigonometrically fixed.	Square miles to each height.	Stations fixed.	Triangular error in seconds.	Error per mile in feet.	Stations fixed.	Triangular error in seconds.	Error per mile in feet.	Intersected points.	Error per mile in feet.	Miles levelled over.	Permanent bench-marks embedded.	Trigonometrical stations connected with.
Inches to a mile 105·6	18	Simla	...	7	...	...	...	...	...	...	...	...	...	...	...	...	...	...
„	Provl. Survey.	Calcutta suburbs	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
64	7	Pakôkku Town	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
16 & 64	Provincial Surveys.	Koil City	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Háthras City	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Sikandra Rao City	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Atrauli City	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Kosi City	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Provl. Surveys.	Bhágalpur City	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
12 & 48	85	Cantonment Surveys.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
26·4	Provl. Surveys.	Allahabad Civil Station	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
16	Provincial Surveys.	United Provinces of Agra and Oudh—Moradabad.	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		United Provinces of Agra and Oudh—Mainpuri.	15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		United Provinces of Agra and Oudh—Jálaun.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Upper Burma—Shwebo	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Pakôkku	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Lower Chindwin.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	7	„ „ Irrawaddy River.	20	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Lower Burma—Kyaukpyu.	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Bengal—Hazáribágh	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Bhágalpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Purnea	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Rangpur	25	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Backergunge	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Midnapore	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Sonthal Parganas	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Ránchi	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Miscellaneous	30	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Detachment.	Central Provinces—Saugor	...	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Seoni	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Nimar	...	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Chánda	...	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Raipur	35	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Betúl	...	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Bhandára.	...	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Sambalpur.	...	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Jubbulpore Town and Cantonments.	...	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Detachment.	Godávari	40	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	17	Bombay Forests	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Provincial Surveys.	Assam—Kámrúp	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Darrang	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Nowgong	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Sibságar	45	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Lakhimpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Carried forward	48	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

Field Parties during the year 1902-03.

	TRAVERSING.				DETAIL SURVEY.					RECORD WRITING.			REMARKS.
	Area in square miles.	Number of stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error per mile.	Area in square miles.	Plane-table fixings per square mile.	Linear miles of test lines.	Villages.	Average size of fields.	Area in square miles.	Villages.	Fields.	
...	...	252	3	0·2	...	...	...	...	...	...	...	...	
...	12	5,818	...	...	3·4	...	...	...	...	...	...	...	
...	12	...	...	...	3·4	...	...	...	...	...	...	...	
...	3·6	899	2	...	3	...	...	...	...	...	...	...	
5	...	...	...	...	4·3	...	...	...	...	...	...	...	
...	...	...	...	...	3·2	...	...	...	...	...	...	...	
...	...	...	...	...	0·9	...	...	...	...	...	...	...	
...	...	...	...	...	1·0	...	...	...	...	...	...	...	
...	...	...	...	...	0·7	...	...	...	...	...	...	...	
10	9	2,413	...	...	...	...	...	...	...	...	...	...	
...	9	...	...	...	10·1	...	...	...	...	...	...	...	
...	41	1,664	6	...	45·7	...	...	...	...	...	...	...	
...	...	...	...	...	2·2	...	...	...	...	...	...	...	
...	140	4,203	5	4	...	...	...	...	...	...	...	...	
15	...	...	...	...	20	...	...	...	...	...	...	...	
...	...	...	...	...	175	...	...	...	...	...	...	...	
...	302	8,156	2	...	...	...	...	...	...	...	...	...	
...	455	7,055	4	0·2	472	...	725	371	0·83	...	...	376,957	
...	...	...	...	...	1	...	...	2	...	...	...	221	
20	...	...	...	...	130	...	...	...	...	...	...	...	
...	42	3,929	4	0·3	74	...	120	148	0·25	...	...	183,312	
...	120	2,063	...	...	...	...	...	...	...	...	...	...	
...	572	11,912	...	...	1,622(*a*)	...	7,806	937(*a*)	0·52	1,594 (*a*)	962	1,952,689	(*a*) Excludes two villages area 1 square mile of district Monghyr.
...	1,189	24,324	...	...	...	...	...	...	...	...	...	...	
25	88	4,855	...	...	...	...	...	...	...	...	...	...	
...	1,027	24,927	...	...	574	...	1,971	390	...	567	408	423,210	
...	653	21,037	...	...	...	...	...	...	...	...	...	...	
...	861 / 1,208(*b*)	39,534	...	...	...	...	...	...	...	...	...	...	(*b*) Skeleton traversing of village tijunctions.
...	1,001	22,944	...	...	617	...	1,942	422	...	437	282	224,204	
30	53	1,470	...	...	21	...	69	9	...	21	9	9,317	
...	87	87	2	0·2	...	...	...	...	...	...	...	...	
...	126	2,336	8	0·9	...	...	...	...	...	...	...	...	
...	10	119	5	0·7	...	...	...	...	...	...	...	...	
...	275	3,513	3	0·6	...	...	...	...	...	...	...	...	
35	163	3,220	6	0·4	...	...	...	...	...	...	...	...	
...	1	41	...	1·1	...	...	...	...	...	...	...	...	
...	9	97	1	0·3	...	...	...	...	...	...	...	...	
...	34	387	5	0·5	...	...	...	...	...	...	...	...	
...	10	254	3	0·4	...	...	...	...	...	...	...	...	
40	131	1,583	4	0·5	131	...	...	31 blocks.	3·10	...	...	26,947	
...	...	...	...	...	6	193	11	...	...	...	...	...	
...	96	1,511	...	...	...	...	...	...	...	...	...	...	
...	40	1,134(*c*)	...	...	...	...	...	...	...	...	...	...	(*c*) Tea Grants and Villages.
...	25	873(*d*)	...	...	...	...	...	...	...	...	...	...	(*d*) Tea Grants.
45	31	860(*c*)	...	...	...	...	...	...	...	...	...	...	
...	81	2,758(*d*)	...	...	...	...	...	...	...	...	...	...	
...	8,836	...	...	...	3,843	...	...	...	...	...	...	...	
48	8,901·6	...	...	...	3,907·4	...	...	...	...	...	...	...	

Summary of the outturn of work of the

Scale of Survey.	Number of Party.	Locale of Operations.		Triangulation.				1st Class.			Secondary.			Tertiary.		Spirit-levelling Operations.		
				Instrument used. Diameter in inches.	Area in square miles.	Square miles to each point trigonometrically fixed.	Square miles to each height.	Stations fixed.	Triangular error in seconds.	Error per mile in feet.	Stations fixed.	Triangular error in seconds.	Error per mile in feet.	Intersected points.	Error per mile in feet.	Miles levelled over.	Permanent bench-marks embedded.	Trigonometrical stations connected with.
Inches to a mile.		Brought forward .	49	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
12	14	Allahabad Cantonments .	50	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8	17	Bombay Forests . .	...	6 & 7	363	0·2	0·2	...	...	...	315	20	0·6	1,625	0·5	...	...	...
4	12	Sind . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	9 & 19	Madras Forests—Ganjam .	...	7	1,090	...	...	...	...	...	37	20	0·4	...	...	...	...	...
		" " Godávari	...	6	350	1·5	1·5	..	...	...	44	25	1·25	189	2·8	...	...	...
		" " South Canara.	55	6	590	2·1	2·1	...	...	...	33	17	0·25	240	0·5	...	...	...
		Madras Forest—Cuddapah	...	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" " Kurnool .	...	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" " Coimbatore	...	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Bombay Forests—Sátára .	...	6	237	0·4	0·4	...	...	...	99	44	0·8	350	1·0	...	...	...
		" " Khándesh	60	6	605	0·3	0·3	...	...	...	239	20	0·6	1,573	0·7	...	...	...
	17	" " " and Násik.	...	6	168	0·3	0·3	...	...	...	105	15	0·6	418	0·7	...	...	...
		" " N. Kánara, Belgaum, Dhárwár and Násik.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Simla	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	18	Montgomery, Lahore, Ferozepore (Sutlej).	...	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Muzaffargarh and Mooltan (Chenab).	65	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Burma Forests—Upper Chindwin and Pakôkku.	...	6	1,161	40·2	40·2	...	...	...	8	21	0·25	16	0·5	...	...	...
	20	Burma Forests—Upper Chindwin, etc.	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Burma Forests, Thayetmyo	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" " Amherst .	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Central Provinces, Mandla	70	5	...	1·5	1·5	...	...	...	130	19	0·8	201	2·4	...	...	...
		" " Chánda	...	5	...	...	...	...	...	...	...	...	...	...	...	171	...	3
		Bengal—Singhbhum .	...	6	...	6·0	6·0	...	...	...	28	13	0·9	13	0·8	...	...	...
		" Kálimpong . .	...	7	285	5·7	5·7	...	...	...	9	25	1·5	25	3·0	...	...	...
		" Kurseong . .	...	7	45	11·3	11·3	...	...	...	3	18	...	...	...	...	...	...
		" Darjeeling . .	75	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Assam—Kámrúp . .	...	5	11	...	...	...	...	...	12	...	...	14	...	...	...	...
		" Gáro Hills . .	...	5	59	...	...	...	...	...	30	...	...	26	...	...	...	...
Forest		Punjab—Pabbi Chenab .	...	7	110	6·9	6·9	...	...	...	6	7	0·9	6	2·5	...	...	...
Branch		" Chenab and Ráwalpindi.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		" Jubbal and Tarhoch	80	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		N.-W. Frontier—Hazára .	...	6	30	1·4	1·4	...	...	...	3	12	0·8	14	1·7	...	...	...
		U. P. of Agra and Oudh, Kumaun.	...	4½ & 7	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		U. P. of Agra and Oudh, Kheri Nepal.	...	4½	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Upper Burma, Ruby Mines	...	6	100	3·8	3·8	...	...	...	8	13	0·4	11	0·6	...	...	...
		" " Bhamo .	85	6	350	29·1	29·1	...	...	...	8	9	0·9	2	2	...	...	...
		" " Mandalay .	...	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Total .	...	...	5,191	...	...	...	...	...	...	...	...	...	...	...	...	...
2	Provincial Survey.	United Provinces of Agra and Oudh, Jumna River.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	12	Sind and Sámbhar Lake .	...	6 & 7	731	23·0	26·0	...	...	...	41	12	0·5	63	0·5	170	24	1
	14	Allahabad . . .	90	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Fatehpur . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	15	N.-W. Frontier—Quetta, Baluchistán.	...	6	400	2·1	2·1	...	...	...	19	13	0·1	166	0·3	...	...	...
			...	6	450	2·8	2·8	...	...	...	16	5	0·1	140	0·5	...	...	...
	18	Montgomery, Lahore, Amritsar.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Simla	95	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Mooltan . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Det.	Central Provinces, Jubbulpore.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Carried forward .	98	...	1,581	...	...	...	...	...	...	...	...	...	...	...	...	...
					5,554													

Field Parties during the year 1902-03.

	TRAVERSING.				DETAIL SURVEY.					RECORD-WRITING.			Remarks.
	Area in square miles.	Number of stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error per mile.	Area in square miles.	Plane-table fixings per square mile.	Linear miles of test lines.	Villages.	Average size of fields.	Area in square miles.	Villages.	Fields.	
49	8,901·6	...	...	...	3,907·4	...	...	...	...	...	...	...	
50	...	...	...	...	6	...	...	...	...	...	...	...	
...	...	...	...	...	240	190	160	...	...	...	...	...	
...	...	...	...	...	91	51	88	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	...	
55	...	...	...	...	249	112	96	...	...	...	...	...	
...	...	7,158	...	...	575	57	33	...	...	...	...	...	
...	...	...	...	...	476	67	28	...	...	...	...	...	
...	...	...	...	...	111	69	10	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	...	
60	...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	487	113	381	...	...	...	...	...	
...	...	...	...	...	2	25	...	...	...	...	...	...	
...	1,158	1,115	6	...	455	8	*in situ*	...	...	...	...	...	
65		7,611	6	3·5	242	5	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	...	
...	...	12,878	5	2·5	465	149	201	...	...	...	...	...	
...	...	3,392	9	6·5	113	133	46(*e*)	...	...	...	...	...	
...	...	1,596	6	3·5	45	167	...	...	...	...	...	...	(*e*) Excludes 25 linear miles, run in Shan States.
70	...	...	...	...	...	...	...	...	...	...	...	...	
...	...	401	6	2·9	226	92	137	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	...	
...	...	186	7	6·1	17	96	3	...	...	...	...	...	
...	...	648	18	3·6	110	145	30	...	...	...	...	...	
75	...	...	...	...	105	144	27	...	...	...	...	...	
...	...	171	...	...	90	141	9	...	...	...	...	...	
...	...	2,567	...	...	44	140	29	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	100	200	21	...	...	...	...	...	
80	...	...	...	...	27	140	*in situ*	...	...	...	...	...	
...	...	...	...	...	173	155	48	...	...	...	...	...	
...	...	1,335	7	2·5	100	133	25	...	...	...	...	...	
...	...	13	...	0·6	...	...	...	...	...	...	...	...	
...	...	4,888	10	11·3	149	128	78	...	...	...	...	...	
85	...	3,611	10	10·5	123	160	79	...	...	...	...	...	
...	...	6,462	9	12·3	31	126	18	...	...	...	...	...	
...	1,158	...	...	...	4,606	...	...	...	...	...	...	...	
...	...	...	...	...	34	46	11	...	...	...	...	...	
...	2,548	9,438	0·5	4·6	1,946	21	1,070	...	...	...	...	...	
90	833	12,485	8	4·3	1,885	27	246	...	...	...	...	...	
...	1,280	17,755	7	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	3,653	5	*in situ*	...	...	...	...	...	
95	...	...	...	...	30	18	...	...	...	...	...	...	
...	3,150	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	1,748 (*f*)	...	...	...	...	...	...	...	(*f*) Excludes 73 square miles of overlap in Native State.
98	7,811	...	...	...	9,296	...	...	...	...	...	...	...	
	10,059·6				8,759·4								

Summary of the cutturn of work of the

Scale of Survey.	Number of Party.	Locale of Operations.		Triangulation.				1st Class.			Secondary.			Tertiary.		Spirit-levelling Operations.		
				Instrument used. Diameter in inches.	Area in square miles.	Square miles to each point trigonometrically fixed.	Square miles to each height.	Station fixed.	Triangular error in seconds.	Error per mile in feet.	Station fixed.	Triangular error in seconds.	Error per mile in feet.	Intersected points.	Error per mile in feet.	Miles levelled over.	Permanent bench-marks embedded.	Trigonometrical stations connected with.
		Brought forward .	99	{ —	5,554													
				{ ...	1,581	...	...	...	...	...	...	...	...	...	...	...	...	...
2	Det.	Central Provinces, Damoh	100	...	....	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Seoni .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Narsinghpur.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Total .	...	...	1,581	...	...	...	...	...	...	...	...	...	...	...	...	...
1	3	Lower Burma . . .	...	6	{ 569 / 1,319 (g)	...	...	...	...	...	29	13	0·1	80	0·8	...	...	...
	10	Upper Burma . . .	105	6	3,403	7·9	8·1	...	...	...	27	7	0·2	235	0·6	...	...	...
	11&21	Upper Burma . . .	...	6	2,797	4·8	5·2	...	...	...	32	10	0·2	600	0·4	...	...	...
	15	Sind	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	18	Simla and Tehri Garhwál .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Total .	...	...	8,088	...	...	...	...	...	...	...	...	...	...	...	...	...
½	12	Sind	110	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Trans-frontier Reconnaissance.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	25	Upper Burma . . .	...	...	...	...	...	...	...	...	...	...	...	...	...	{ 198(i) / 17(j) } 31		
		Total .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		GRAND TOTAL .	114	...	15,223	...	...	...	...	...	...	...	...	...	...	...	...	...

Field Parties during the year 1902-03.

	TRAVERSING.			DETAIL SURVEY.						RECORD-WRITING.			REMARKS.
	Area in square miles.	Number of stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error per mile.	Area in square miles.	Plane-table fixings per square mile.	Linear miles of test lines.	Villages.	Average size of fields.	Area in square miles.	Villages.	Fields.	
...	10,059·6 7,811	...	...	...	8,759·4 9,296	...	...	...	...	...	...	...	
...	...	...	...	...	187	(f) 14	...	...	...	...	...	...	(f) Excludes 73 square miles of overlap in Native States.
...	...	...	...	...	157								
100	...	...	...	...	182								
...	7,811	...	...	...	9,822	...	...	...	...	...	...	...	
...	324	682	*Nil*	9·6	1,786 2,934(g)	23	175	...	...	...	...	...	(g) Supplementary.
105	...	178	16	3·1	3,336	7	962	...	...	...	...	...	
...	...	...	...	...	2,432	...	*in situ*	...	...	...	...	...	
...	103	...	...	...	1,499(h)	6	163	...	...	...	...	...	(h) Excludes 1,033 square miles of revision survey in Khágan valley, district Házara.
...	...	...	...	...	65	4	...	...	...	...	...	...	
...	427	...	...	...	12,052	...	...	...	...	...	...	...	
110	...	...	...	...	2,164	1	276	...	...	...	...	...	
...	...	...	...		38,000	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	...	(i) Double levelling. (j) Branch lines.
...	...	...	...	...	40,164	...	...	...	...	...	...	...	
114	18,297·6	...	...	...	70,797·4	...	...	...	...	...	...	...	

Statement showing the cost-rates of work executed

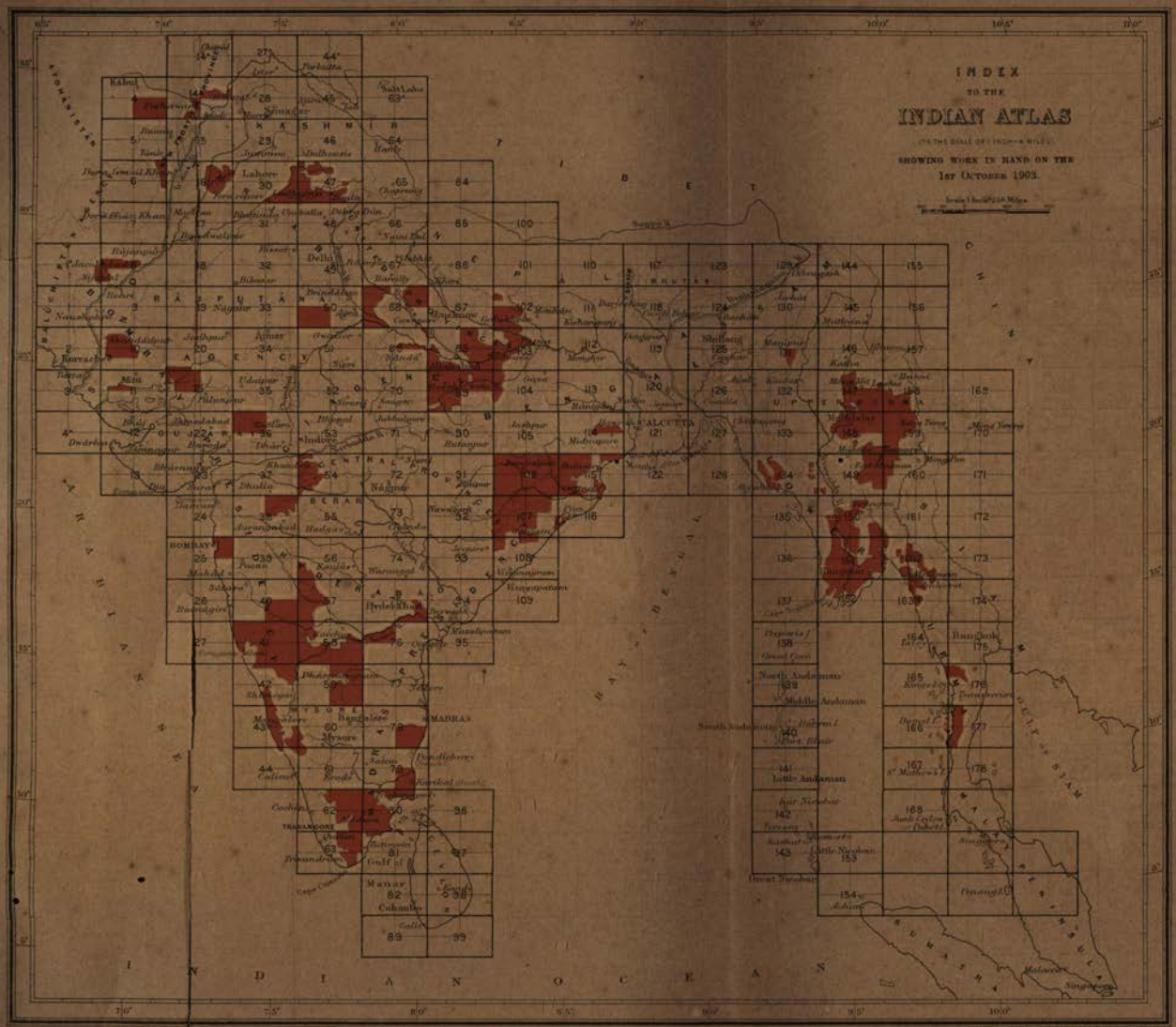
Number of Party.	Nature and *locale* of field operations.	Cost-rate per square mile.									
		Triangulation.	Traversing.	Detail survey and preparation of maps on scales of							
				1/8"	1/4"	1/2"	1"	2"	4"	8"	12"
	Topographical Surveys.	₹	₹	₹	₹	₹	₹	₹	₹	₹	₹
3	Lower Burma	8·1 suppy 2·9	12·1 ...	...	...	...	21·8 11·5	...	...	...	...
10	Upper Burma	12·1	...	...	...	...	19·2	...	...	...	...
11 & 21	Upper Burma	10·5	...	...	...	...	28·2	...	...	...	...
12	Sind	14·2	13·8	...	...	5·5	...	13·2	48·5	...	...
14	Allahabad Fatehpur	...	12"=28·8 2"=26·6	... ...	...	...	... ...	6·5 ...	...	...	85·0 ...
15	Sind	...	...	...	...	...	12·3	...	...	...	...
	North-West Frontier	8·5	12" & 48"=90·6	...	...	...	...	...	...	...	439·5
18	Himalaya	...	2"= 8·8 4"= 8·9	...	...	...	8·4	5·3	...	...	...
	Forest Surveys.										
9 & 19	Madras	5·4	50·6	...	...	...	...	...	58·0	...	...
17	Bombay	4"=10·8 8"=12·1	...	...	...	...	...	...	61·0	130·1	...
20	Burma	3·2	44·7(g)	...	...	...	...	...	136·6	...	...
Forest Branch.	Mandalay, etc.	10·0	37·2(g)	...	...	...	...	...	63·5	...	...
	Chánda		8·4(g)	...	...	...	...	...	25·7	...	...
	Darjeeling, etc.	4·8	18·1(g)	...	...	...	...	...	64·0	...	...
	Kámrúp and Gáro Hills	37·3	33·2(g)	...	...	...	...	...	97·8	...	...
	Chamba, Chenab, and Ráwalpindi	3·5	...	...	...	...	...	...	34·2	...	...
	Hazára	9·1	...	...	...	...	...	...	24·2	...	...
	Jubbal	...	...	...	...	...	...	...	47·4	...	...
	Kumaun	...	5·7(g)	...	...	...	...	...	29·7	...	...
	Cadastral Surveys.										
Detachment.	United Provinces of Agra and Oudh	...	29·5	...	...	...	...	14·5	...	...	...
Bengal Surveys.	Hazáribágh	...	35·0	...	...	...	...	...	...	...	...
	Bhágalpur	...	26·6	...	...	...	...	...	...	...	61·3
	Purnea	...	24·3	...	...	...	...	...	...	...	...
	Rangpur	...	57·3	...	...	...	...	...	...	...	...
	Backergunge	...	43·6	...	...	...	...	...	...	...	114·7
	Midnapore	...	38·5	...	...	...	...	...	...	...	...
	Sonthal Parganas	...	28·3 14·1(n)	...	...	...	...	...	...	...	...
	Ránchi	...	28·9	...	...	...	...	...	...	...	61·7
	Monghyr	...	...	...	...	...	...	...	...	...	78·0
7	Upper Burma, Shwebo	...	73·4	...	...	...	...	...	...	...	...
	„ „ Pakôkku	...	49·0	...	...	...	...	...	...	...	116·9
	Lower Burma, Kyaukpyu	...	412·4	...	...	...	...	...	...	...	536·3
Detachment.	Godávari	...	24·0	...	...	...	...	...	...	...	119·3
	Traverse Surveys.										
Detachment.	Central Provinces	...	14·5	...	...	...	...	9·7	...	...	...
Provincial Surveys.	Kámrúp	...	19·9	...	...	...	...	...	...	...	...
	Darrang	...	53·5(s) 54·7	...	...	...	...	...	...	...	...
	Nowgong	...	78·0(s)	...	...	...	...	...	...	...	...
	Sibságar	...	62·1 62·9(s)	...	...	...	...	...	...	...	...
	Lakhimpur	...	83·5(s)	...	...	...	...	...	...	...	...

Field Parties during the year 1902-03.

Cost-rate per acre, cadastral survey, including traversing, detail survey and mapping.	Cost-rate per square mile.			Total cost inclusive of charges for instruments to Provincial Government.	Remarks.
	Stone embedding.	Records (*Khanapuri.*)	Completion of Vernacular Records, Assessment, Statistics, etc.		
R a. p.	R	R	R	R	
...	...	...	...	95,000	(a) Includes R5,472 expended on revision survey of Maymyo city on 16" scale.
...	...	...	...	1,05,950(a)	(b) Includes R11,679 expended on miscellaneous compilation work.
...	...	...	...	1,09,564(b)	(c) Includes R7,397 expended on triangulation, levelling and 2" survey of Sambhar Salt lake; R12,316 on mapping.
...	...	...	...	1,02,151(c)	(d) Includes R1,138 expended in bringing up arrears of Lushai triangulation.
...	3 0	...	...	76,665(d)	(e) Includes R4,894 expended on detail survey in Kashmir; R4,504 on 6" Khojak survey, R4,268 on 1,033 sq. miles of revision survey in Khojak; R5,015 on arrears of mapping; R5,983 on leave pay, Drawing Office, etc.
...	...	...	...	85,918(e)	
...	...	...	...		(f) Includes R5,198 expended on 50 feet to the inch survey of Simla city; R1,765 on instruction of officers; R4,704 on 1", 2" and 4" mapping.
...	...	...	...	85,345(f)	
					(g) Rate per linear mile.
					(h) Includes R7,091 expended for mapping and publication.
...	...	...	...	99,564	(i) Includes R1,002 expended on levelling, R1,615 on 16" boundary survey.
...	...	...	...	77,086	(j) Includes R281 expended on 4" boundary survey.
...	...	...	...	1,48,468(h)	(k) Includes R56 expended on levelling.
...	...	...	...	85,316	(l) Rates for Mainpuri and Jalaun.
...	...	...	...	8,924(i)	(m) Includes R51,920 expended on miscellaneous surveys; R30,298 on standard mapping; R78,072 on reproduction of village maps; R3,898 on Thana maps and R13,958 on Orissa and Bihar *badars*.
...	...	...	...	18,268	
...	...	...	...	19,668	(n) Rate of skeleton traversing of *trijunctions*.
...	...	...	...	4,087(j)	(o) Includes R5,371 on Pakôkku city survey on 64" scale and R4,482 on mapping.
...	...	...	...	4,453	(p) Includes R1,902 on mapping.
...	...	...	...	2,279	(q) Includes R1,724 on triangulation.
...	...	...	...	3,971(k)	(r) Includes R5,968 on Drawing Section.
					(s) Tea Grants.
...	...	...	...	1,24,928	(t) Includes R14,343 on maintenance of Records; R3,594 on Sylhet Boundary Commission; R1,764 on mapping standard sheets; R226 on traversing for 16" survey in district of Cachar.
...	...	71·2	...		
...	...	...	...		
...	...	...	...		
...	...	53·0	...	23,205(m)	
...	...	...	...		
...	...	...	...		
...	...	39·3	...		
...	...	46·0	...		
...	12·1	...	...		
0 4 5	12·2	...	6·2	13,703(o)	
1 9 10	25·8	...	40·5		
...	...	1·5	...	9,225(p)	
				10,693(q)	
...	...	...	...		
...	...	...	...	37,934(r)	
...	...	...	...		
...	...	...	...		
...	...	...	...		
...	...	...	...	14,669(s)	
...	...	...	...		

Field Parties during the year 1902-03.

Cost-rate per acre, cadastral survey, including traversing, detail survey and mapping.	Cost-rate per square mile.			Total cost inclusive of charges for instruments to Provincial Government.	Remarks.
	Stone embedding.	Records (*Khanapuri.*)	Completion of Vernacular Records, Assessment, Statistics, etc.		
₹ a. p.	₹	₹	₹	₹	
...	...	...	...	95,000	(*a*) Includes ₹5,472 expended on revision survey of Maymyo city on 16" scale.
...	...	...	...	1,05,950(*a*)	(*b*) Includes ₹11,679 expended on miscellaneous compilation work.
...	...	...	...	1,09,564(*b*)	(*c*) Includes ₹7,397 expended on triangulation, levelling and 2" survey of Sambhar Salt lake; ₹12,316 on mapping.
...	...	...	...	1,02,151(*c*)	(*d*) Includes ₹1,138 expended in bringing up arrears of Lushai triangulation.
...	3 0	...	...	76,665(*d*)	(*e*) Includes ₹4,894 expended on detail survey in Kashmir; ₹4,504 on 6" Khojak survey, ₹4,268 on 1,033 sq. miles of revision survey in Khojak; ₹5,015 on arrears of mapping; ₹5,983 on leave pay, Drawing Office, etc.
...	...	...	...	85,918(*e*)	
...	...	...	...		(*f*) Includes ₹5,198 expended on 50 feet to the inch survey of Simla city; ₹1,765 on instruction of officers; ₹4,704 on 1", 2" and 4" mapping.
...	...	...	...	85,345(*f*)	
					(*g*) Rate per linear mile.
					(*h*) Includes ₹7,091 expended for mapping and publication.
...	...	...	...	99,664	(*i*) Includes ₹1,002 expended on levelling, ₹1,615 on 4" boundary survey.
...	...	...	...	77,086	(*j*) Includes ₹281 expended on 4" boundary survey.
...	...	...	...	1,48,468(*h*)	(*k*) Includes ₹56 expended on levelling.
...	...	...	...	55,316	(*l*) Rates for Mainpuri and Jalaun.
...	...	...	...	8,924(*i*)	(*m*) Includes ₹51,929 expended on miscellaneous surveys; ₹30,298 on standard mapping; ₹78,072 on reproduction of village maps; ₹3,898 on Thana maps and ₹13,958 on Orissa and Bihar *sadars*.
...	...	...	...	18,268	
...	...	...	...	19,668	(*n*) Rate of skeleton traversing of trijunctions.
...	...	...	...	4,087(*j*)	(*o*) Includes ₹5,371 on Pakôkku city survey on 64" scale and ₹4,482 on mapping.
...	...	...	...	4,453	(*p*) Includes ₹1,902 on mapping.
...	...	...	...	1,279	(*q*) Includes ₹1,724 on triangulation.
...	...	...	...	3,971(*k*)	(*r*) Includes ₹5,968 on Drawing Section.
					(*s*) Tea Grants.
...	...	...	...	1,24,928	(*t*) Includes ₹14,343 on maintenance of Records; ₹3,594 on Sylhet Boundary Commission; ₹1,764 on mapping standard sheets; ₹226 on traversing for 16" survey in district of Cachar.
...	...	...	...		
...	...	31·2	...		
...	...	...	...		
...	...	...	...		
...	...	58·0	...	18,53,205(*m*)	
...	...	...	...		
...	...	...	...		
...	...	39·3	...		
...	...	46·0	...		
...	12·1	...	...	1,43,703(*o*)	
0 4 5	12·2	...	6·2		
1 9 10	25·8	...	40·5	69,225(*p*)	
...	...	1·5	...	20,693(*q*)	
...	...	...	...	37,934(*r*)	
...	...	...	...		
...	...	...	...		
...	...	...	...	34,669(*t*)	
...	...	...	...		
...	...	...	...		



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July 1902.

No. 639-S 1902.

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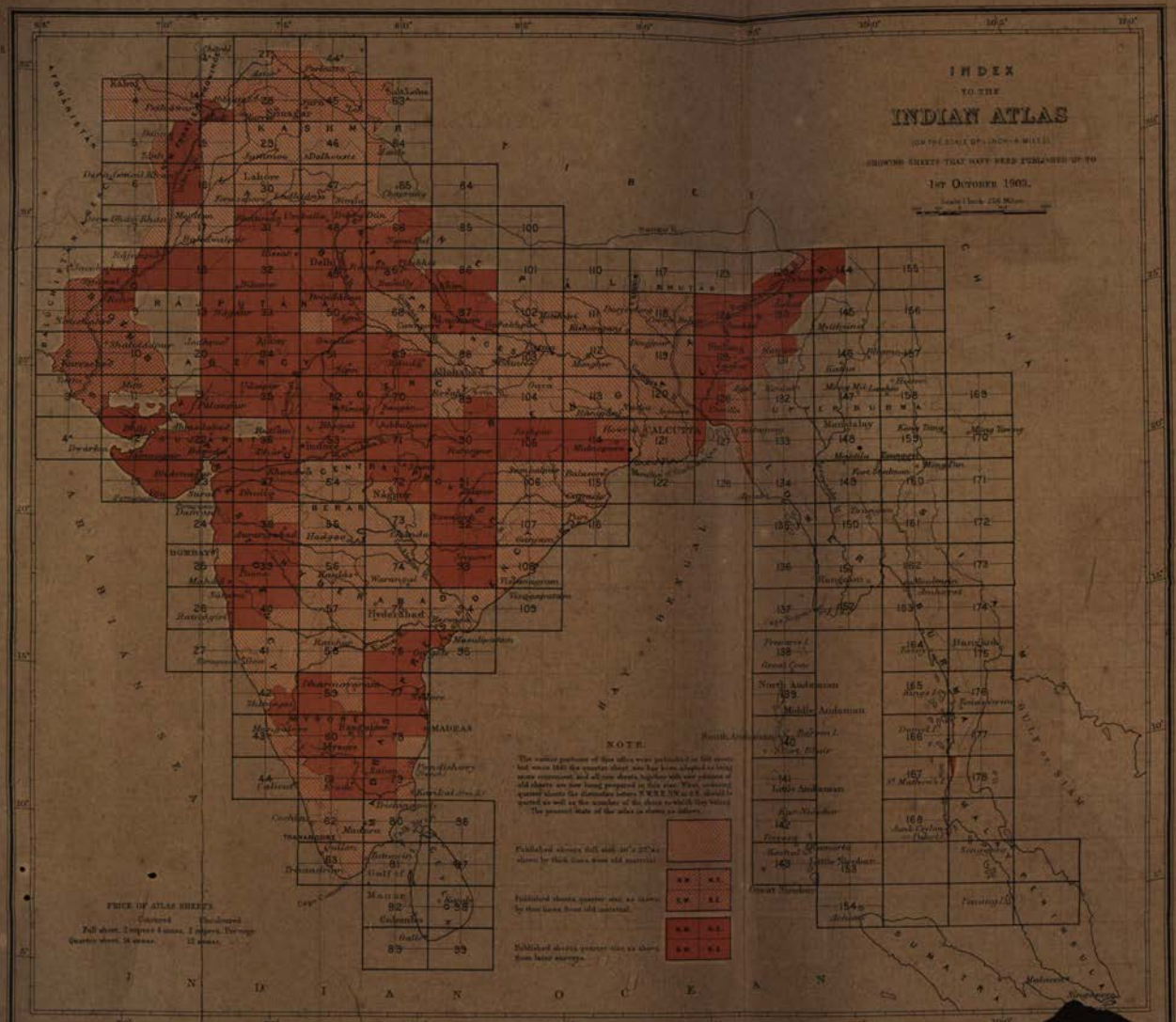
Litho. S. I. O. Calcutta.



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APPENDIX.

Abstract showing the Approximate Magnetic Values at Stations observed at by No. 26 Party during Season, 1902-03.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
164	Jhajra	39/78 2	30 20 30	77 54 50	43 15	E 2 40	...	
165	Ambári	„ 1	30 29 20	77 48 20	43 30	„ 2 45	...	
166	Mirzapur	„ 3	30 15 30	77 37 40	43 10	„ 2 45	...	
167	Ghuna	„ 4	30 3 50	77 34 40	42 50	„ 2 40	...	
168	Fatehpur	„ 5	30 2 40	77 45 40	42 45	„ 2 45	...	
169	Kalyán	39/74 6	19 15 0	73 8 20	23 35	„ 0 25	0·3645	
170	Lonávla	44/74 1	18 45 10	73 24 20	22 10	„ 0 15	0·3720	
171	Kirkee	„ 2	18 33 30	73 50 0	22 5	„ 0 35	0·3705	
172	Dhond	„ 3	18 28 0	74 35 10	21 20	„ 0 25	0·3720	
173	Jeúr	48/78 1	18 15 50	75 9 40	21 5	„ 0 15	0·3730	
174	Bársi	„ 2	18 14 30	75 42 20	21 0	„ 1 0	0·3745	
175	Hotgi	„ 3	17 33 40	76 0 20	19 50	„ 0 30	0·3735	
176	Ghangapur	„ 4	17 20 20	76 36 0	18 30	„ 0 40	0·3765	
177	Vadi Junction	48/78 1	17 3 0	77 0 0	18 10	„ 0 25	0·3765	
178	Vádgiri	46/78 1	16 44 40	77 8 10	17 35	„ 0 20	0·3765	
179	Ráichur	„ 2	16 12 0	77 20 30	16 30	„ 0 15	0·3790	
180	Ádóni	„ 3	15 37 0	77 16 30	15 15	„ 0 15	0·3790	
181	Guntakal	„ 4	15 10 20	77 22 40	14 40	„ 0 15	0·3805	
182	Kondápuram	44/78 2	14 46 20	78 11 40	13 20	W 0 10	0·3825	
183	Cuddapah	„ 4	14 27 10	78 49 20	12 35	E 0 5	0·3815	
184	Reddipalle	42/78 2	14 5 30	79 14 0	11 45	W 0 10	0·3820	
185	Rénigunta	„ 3	13 38 20	79 30 50	10 40	„ 0 5	0·3810	
186	Arkónam	„ 5	13 4 30	79 40 20	9 40	„ 0 10	0·3835	
187	Perambúr	„ 6	13 6 40	80 15 0	9 55	„ 0 10	0·3850	
188	Kátpádi	13/78 1	12 58 40	79 7 40	9 20	„ 0 15	0·3840	
189	Jalárpet	38/78 3	12 34 0	78 34 10	8 45	„ 0 35	0·3800	
190	Bowringpet	„ 1	12 58 50	78 11 0	9 20	„ 0 20	0·3810	
191	Morappúr	„ 4	12 7 30	78 21 40	7 15	„ 0 30	0·3845	
192	Salem	„ 5	11 40 0	78 6 50	5 25	„ 0 50	0·3820	
193	Erode	„ 6	11 19 40	77 43 50	5 30	„ 0 30	0·3820	
194	Sómanúr	„ 7	11 5 10	77 11 0	5 10	„ 0 30	0·3780	
195	Coonoor	13/78 6	11 20 40	76 47 50	5 40	„ 0 25	0·3795	
196	Olavakod	49/78 2	10 48 10	76 38 20	4 30	„ 0 40	0·3775	
197	Pattámbi	„ 1	10 48 10	76 10 40	5 5	„ 0 25	0·3750	
198	West hills	13/78 7	11 17 10	75 45 20	7 35	„ 0 10	0·3865	
199	Cannanore	„ 5	11 52 30	75 22 0	7 0	„ 0 5	0·3825	
200	Vottekolli	„ 3	12 7 20	75 50 20	7 35	„ 0 35	0·3785	
201	Húnsúr	„ 2	12 18 20	76 16 50	7 40	„ 0 40	0·3790	
202	Nanjangúd	„ 4	12 7 40	76 40 40	7 30	„ 0 30	0·3820	
203	Seringapatam	„ 1	12 25 30	76 40 40	8 5	„ 0 20	0·3800	
204	Channapatna	13/78 2	12 39 40	77 12 0	8 50	„ 0 20	0·3820	
205	Túmkúr	14/78 10	13 20 0	77 6 0	10 5	E 0 15	0·3785	
206	Tiptur	14/78 5	13 15 10	76 28 30	10 5	W 0 15	0·3795	
207	Birur	„ 4	13 35 50	75 58 10	10 45	„ 0 10	0·3795	
208	Shimoga	„ 3	13 55 30	75 34 0	11 20	„ 0 5	0·3780	
209	Sásalu	„ 2	14 12 40	76 6 40	12 10	„ 0 10	0·3790	
210	Ránebennur	„ 1	14 37 0	75 38 30	13 0	„ 0 0	0·3785	
211	Valvigi	14/78 1	15 1 50	75 25 0	14 5	E 0 10	0·3765	
212	Mormugao	14/74 5	15 24 10	73 47 30	15 10	„ 0 25	0·3770	
213	Castle Rock	„ 6	15 24 0	74 18 50	13 55	W 0 10	0·3820	
214	Belgaum	„ 4	15 50 30	74 31 10	15 50	„ 0 15	0·3735	
215	Gokák Road	„ 3	16 14 0	74 44 40	16 25	E 0 15	0·3770	
216	Miraj	„ 1	16 49 10	74 38 10	18 30	„ 0 5	0·3795	
217	Kolhápur	„ 2	16 41 50	74 14 10	17 25	„ 0 25	0·3755	
218	Karad	42/74 6	17 18 40	74 13 10	19 5	„ 0 25	0·3730	
219	Wathar	„ 5	17 53 20	74 8 10	20 20	„ 0 25	0·3715	
220	Rajewádi	„ 4	18 23 0	74 8 30	20 55	„ 0 25	0·3705	
221	Ahmednagar	49/74 7	19 4 20	74 43 10	22 35	„ 0 30	0·3705	
222	Puntámba	„ 4	19 45 40	74 37 20	23 55	„ 1 10	0·3690	
223	Manmád	„ 2	20 14 40	74 26 20	24 35	„ 0 55	0·3665	
224	Khervádi	„ 3	20 2 50	73 58 10	25 10	„ 0 50	0·3670	
225	Igatpuri	„ 5	19 41 20	73 34 40	24 0	„ 0 35	0·3650	
226	Dhulia	„ 1	20 53 19	74 45 20	26 0	„ 0 50	0·3670	
227	Chálisgaon	49/78 1	20 27 30	75 1 0	25 0	„ 0 55	0·3665	
228	Lhaksar	49/78 7	29 45 20	78 1 20	42 5	„ 2 35	0·3370	
229	Saháranpur	„ 6	29 57 50	77 32 40	42 35	„ 2 45	0·3360	
230	Muzaffarnagar	„ 8	29 28 30	77 42 0	41 50	„ 2 35	0·3385	

Abstract showing the Approximate Magnetic Values at Stations observed at by No. 26 Party during Season, 1902-03—contd.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
231	Meerut City	1	28 58 40	77 41 0	40 55	E 2 30	0·3405	
232	Delhi	2	28 40 20	77 14 20	40 30	„ 2 10	0·3415	
233	Samálkha	9	29 14 40	77 0 10	41 20	„ 2 35	0·3385	
234	Taráori	8	29 48 20	76 56 0	42 15	„ 2 40	0·3365	
235	Sangaria	6	29 47 50	74 27 40	42 15	„ 2 25	0·3345	
127	Súratgarh	„ 5	29 20 0	73 54 30	41 30	„ 2 35	0·3360	
236	Balochia	„ 11	29 14 50	73 27 20	41 20	„ 2 30	0·3355	
237	Walar or Sardárgarh.	„ 10	29 15 30	73 1 40	41 25	„ 2 25	0·3340	
238	Ranabhana Toba	6	28 54 30	72 38 10	41 5	„ 2 0	0·3350	
239	Maujagarh	13	29 0 50	72 8 20	40 50	„ 2 15	0·3365	
240	Kumhariwála	8	28 32 0	72 14 10	41 15	„ 3 5	0·3365	
24	Khángarh	„ 2	28 22 10	71 42 50	40 10	„ 2 5	0·3385	
241	Lohita Tibba	„ 11	27 55 10	71 32 10	39 50	„ 1 50	0·3400	
242	Sarwar ka Toba	„ 9	28 17 30	71 6 40	39 45	„ 2 20	0·3370	
243	Islamgarh	13	27 51 30	70 48 40	39 15	„ 2 10	0·3370	
244	Maruwala Toba	„ 11	28 15 30	70 38 50	39 45	„ 2 10	0·3355	
245	Bher Tibba	„ 12	28 0 25	70 22 10	39 30	„ 2 20	0·3375	
57	Sadikabad	„ 2	28 18 10	70 7 40	40 0	„ 2 35	0·3365	
246	Ganeshgarh	7	29 45 0	73 54 0	42 10	„ 2 50	0·3340	
247	Lálgarh	„ 8	29 38 20	73 22 50	42 0	„ 2 35	0·3335	
248	Gegra	7	28 49 10	73 15 0	40 35	„ 2 30	0·3305	
249	Kelasar	„ 8	28 28 0	73 15 20	40 15	„ 2 20	0·3385	
250	Pungal	7	28 30 50	72 48 40	40 10	„ 2 5	0·3385	
251	Angnao	„ 10	28 6 0	72 47 0	39 35	„ 2 20	0·3400	
252	Hadda	„ 12	27 37 50	72 52 30	38 50	„ 2 5	0·3415	
253	Ranisar	„ 13	27 12 40	72 42 40	37 55	„ 2 5	0·3425	
254	Panchora	13	27 6 40	73 13 30	38 0	„ 1 25	0·3445	
255	Khetasar	3	26 41 0	72 49 20	37 10	„ 1 50	0·3465	
256	Jodhpur	8	26 16 20	73 1 30	36 20	„ 1 25	0·3480	
257	Marwar Páli	„ 9	25 47 50	73 19 30	35 30	„ 1 40	0·3495	
258	Dundára	4	25 53 40	72 47 50	35 45	„ 1 30	0·3475	
259	Bálotra	„ 5	25 50 10	72 14 40	36 40	„ 1 25	0·3515	
260	Kavas	„ 6	25 52 15	71 31 40	35 20	„ 2 5	0·3470	
261	Bhachbhar	„ 7	25 44 0	70 59 0	36 25	„ 2 25	0·3420	
262	Jaisingder	9	25 45 40	70 24 30	35 35	„ 1 50	0·3440	
135(*a*)	Dhoro Naro	„ 7	25 29 50	69 33 50	34 55	„ 2 0	0·3465	
263	Dugoli	12	27 22 0	74 10 20	38 15	„ 2 10	0·3440	
264	Bana	„ 10	27 58 40	74 1 50	39 15	„ 2 10	0·3415	
265	Sardárshahr	„ 9	28 26 10	74 28 50	40 5	„ 2 30	0·3395	
266	Saringsar	„ 6	28 54 40	74 28 30	40 50	„ 2 25	0·3380	
267	Mirjawali	9	29 20 40	74 30 20	41 30	„ 2 25	0·3360	
268	Malsisar	1	28 58 20	75 1 30	40 55	„ 2 30	0·3375	
269	Sarpura	„ 2	28 40 20	75 37 0	40 30	„ 2 25	0·3395	
270	Tamkor	„ 4	28 26 20	75 15 10	40 0	„ 2 20	0·3415	
271	Fatehpur	„ 7	28 0 30	74 57 20	39 35	„ 2 0	0·3425	
272	Singrawat	11	27 26 10	74 52 50	38 25	„ 1 55	0·3450	
273	Khátu	12	27 22 10	75 24 10	38 5	„ 2 10	0·3440	
274	Gudha	„ 9	27 51 40	75 31 40	39 0	„ 2 15	0·3435	
275	Koharwas	„ 5	28 15 40	75 57 30	39 40	„ 2 25	0·3425	
276	Nangal Chaudhri.	„ 8	27 53 30	76 6 20	39 10	„ 1 45	0·3440	
277	Shahpura	„ 11	27 23 30	75 58 0	38 15	„ 1 55	0·3440	
162	Jaipur	2	26 55 0	75 47 0	37 45	„ 2 5	0·3465	
278	Alwar	10	27 33 40	76 38 0	38 40	„ 2 15	0·3450	
279	Rewári	„ 6	28 12 20	76 36 20	39 50	„ 2 15	0·3425	
280	Dádri	„ 3	28 36 10	76 16 40	40 35	„ 2 15	0·3390	
281	Hánsi	12	29 5 40	75 57 0	41 10	„ 2 30	0·3380	
282	Adampur	„ 11	29 17 20	75 27 50	41 30	„ 2 20	0·3360	
283	Sirsa	„ 10	29 32 10	75 2 40	41 50	„ 2 40	0·3355	
284	Budhláda	„ 7	29 55 30	75 33 20	42 25	„ 2 35	0·3335	
285	Kaláyat	„ 9	29 41 10	76 13 40	42 5	„ 2 25	0·3340	
286	Karainth	„ 13	29 1 10	76 29 0	41 15	„ 2 10	0·3390	
287	Tokara	„ 14	30 50 50	76 55 20	43 55	„ 2 55	0·3310	
67	Patiála	„ 4	30 20 40	76 24 0	43 10	„ 2 50	0·3335	
66	Alal	„ 3	30 21 50	75 43 50	...	...	0·3325	
65	Bhuchhu	„ 6	30 12 50	75 5 30	...	...	0·3330	
64	Malaut	3	30 11 0	74 29 40	42 50	„ 2 45	0·3325	
63(*a*)	Orki (*a*)	„ 2	30 8 40	73 54 30	...	...	0·3325	
62	Rojhánwáli	„ 4	30 0 50	73 15 40	...	...	0·3320	
61	Bakhshankhan	4	29 44 30	72 42 50	...	...	0·3330	
60	Asrani	„ 6	29 31 30	72 8 10	...	...	0·3335	
37	Samsata	„ 7	29 21 10	71 32 30	41 30	„ 3 0	0·3355	
59	Chani Got	„ 8	29 5 10	71 1 30	...	...	0·3340	
58(*a*)	Khánpur (*a*)	1	28 38 50	70 39 10	...	...	0·3355	
57	Sadikabad	„ 2	28 18 10	70 7 40	...	...	0·3305	

Abstract showing the Approximate Magnetic Values at Stations observed at by No. 26 Party during Season, 1902-03—contd.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
55	Pano Ákil	55/70 5	27 50 50	69 6 50	38 55	E 2 15	0·3370	
46	Ruk	46/62 3	27 48 20	68 38 20	...	...	0·3370	
52	Jhatpat	,, 2	28 22 20	68 19 20	...	...	0·3340	
53	Bellpat	,, 1	28 59 40	68 0 20	...	...	0·3315	
54(a)	Sibi (a)	52/68 1	29 32 40	67 51 40	41 45	,, 2 40	0·3280	
288	Chachar	33/38 8	28 12 10	68 9 20	39 45	,, 2 10	0·3345	
289	Shahdadpur	,, 9	27 51 0	67 54 40	39 10	,, 2 20	0·3365	
290	Guibe Dera	,, 10	27 36 0	67 38 50	38 35	,, 2 20	0·3375	
291	Gote Mado	,, 11	27 11 20	67 35 30	37 50	,, 2 20	0·3390	
292	Haira Khan	24/38 12	26 49 20	67 28 10	37 15	,, 2 10	0·3400	
293	Tando Rahim Khan.	,, 13	26 30 30	67 25 40	36 45	,, 2 0	0·3415	
294	Narani	,, 14	26 7 30	67 32 50	35 55	,, 1 55	0·3440	
295	Pokrun Lundi	,, 16	25 48 30	67 44 30	35 25	,, 1 50	0·3445	
296	Belo	,, 15	25 47 10	67 26 50	35 15	,, 1 50	0·3445	
297	Kund	,, 17	25 34 50	67 19 0	35 0	,, 1 50	0·3450	
298	Kharr	,, 18	25 17 20	67 7 50	34 30	,, 1 40	0·3455	
39	Dabeji	24/28 2	24 48 50	67 29 50	...	...	0·3475	
40	Jhimpir	21/28 11	25 1 50	68 0 50	...	...	0·3470	
41	Hyderabad	,, 10	25 22 30	68 22 30	34 35	,, 1 45	0·3405	
42	Shadadpur	,, 7	25 55 40	68 37 50	...	...	0·3450	
43	Daur	,, 4	26 27 40	68 18 30	...	...	0·3425	
44	Kandiáro Road	,, 1	26 59 20	68 20 50	...	...	0·3415	
45	Khairpur	25/68 5	27 31 10	68 44 20	38 20	,, 2 0	0·3380	
47(a)	Lárkhána Nazzr	,, 4	27 32 30	68 11 50	...	...	0·3375	
48	Sita Road	,, 6	27 2 30	67 51 10	...	...	0·3400	
49	Bubak Road	28/38 3	26 29 0	67 46 10	...	...	0·3425	
50	Sann	,, 6	26 1 40	68 6 50	35 45	,, 1 50	0·3440	
51	Petaro	,, 8	25 32 0	68 19 10	...	...	0·3460	
299	Hamid Pawhar	,, 7	28 26 0	68 46 50	39 50	,, 2 15	0·3340	
300	Bela (Taz)	44/78 9	28 23 40	69 14 10	39 50	,, 2 20	0·3350	
301	Bara	,, 10	28 33 0	69 39 30	40 0	,, 2 40	0·3345	
302	Tuziani	,, 8	28 56 40	69 54 40	40 50	,, 2 45	0·3330	
303	Drigri	48/78 7	29 24 30	70 8 30	41 40	,, 2 50	0·3320	
304	Ganehar	,, 6	29 44 0	70 20 20	42 15	,, 2 40	0·3290	
305	Vidor	,, 4	30 5 10	70 32 20	42 35	,, 2 45	0·3300	
306	Mandrani	,, 3	30 25 20	70 36 50	43 20	,, 2 50	0·3280	
307	Jhok Bodo	,, 1	30 55 0	70 32 20	43 55	,, 3 5	0·3250	
308	Gurwáli	23/78 5	31 21 50	70 29 0	44 25	,, 3 10	0·3240	
309	Darában	,, 4	31 44 0	70 19 40	45 0	,, 3 15	0·3235	
310	Tánk	,, 3	32 12 30	70 23 20	46 15	,, 3 15	0·3160	
311	Darra Pezu	,, 2	32 19 20	70 44 20	46 10	,, 3 20	0·3180	
312	Sarai Naurang	,, 1	32 49 40	70 47 0	46 50	,, 3 25	0·3150	
313	Latammar	15/16 2	33 7 0	70 51 50	47 5	,, 3 35	0·3145	
314	Bánda Dáúd Shah.	11/13 9	33 16 40	71 11 10	47 25	,, 3 25	0·3130	
315	Kohát	,, 8	33 34 40	71 26 30	47 45	,, 3 35	0·3125	
316	Thal	11/13 1	33 21 50	70 33 50	47 30	,, 3 30	0·3130	
317	Dhanda	12/13 6	32 46 30	71 57 40	46 50	,, 3 25	0·3160	
318	Talagang	,, 7	32 55 50	72 25 0	47 15	,, 3 25	0·3155	
319	Chakwál	,, 8	32 56 10	72 51 10	47 5	,, 3 25	0·3160	
320	Khaie Kutan	,, 10	31 46 50	72 11 0	45 35	,, 3 0	0·3215	
321	Atháránhazári	,, 13	31 10 30	72 5 40	44 25	,, 2 40	0·3235	
322	Nawankot	,, 14	31 6 30	71 31 0	44 5	D 3 0	0·3265	
323	Rangpur	12/18 10	30 31 0	71 34 50	43 10	,, 3 5	0·3285	
324	Muzaffargarh	,, 11	30 4 40	71 10 50	42 25	,, 2 50	0·3305	
70	Kartárpur	13/17 3	31 26 10	75 29 30	...	...	0·3270	
69	Ladhowal	10/16 1	30 59 0	75 47 20	...	...	0·3295	
68	Sirhind	,, 2	30 37 40	76 22 40	...	...	0·3315	
325	.....	...	...	...	...	...	...	
326	.....	...	...	...	...	...	...	
327	Tuticorin	8/18 1	8 48 10	78 9 0	0 25	W 0 50	0·3810	
328	Palamcottah	,, 2	8 42 50	77 44 30	0 10	,, 0 50	0·3800	
329	Koilpati	10/18 7	9 10 30	77 51 50	0 35	,, 0 55	0·3805	
330	Ammayanayákkanúr.	,, 4	10 10 30	77 54 20	2 40	,, 0 35	0·3820	
331	Manappárai	,, 3	10 36 40	78 25 30	3 55	,, 0 40	0·3840	
332	Mandapam	10/18 3	9 16 50	79 8 30	1 0	,, 0 45	0·3815	
333	Sathirakkudi	10/18 6	9 24 0	78 42 10	1 5	,, 0 50	0·3805	
334	Tiruppuvanam	,, 5	9 49 20	78 15 40	2 5	,, 0 50	0·3795	
335	Trichinopoly	,, 2	10 47 30	78 40 40	4 20	,, 0 35	0·3815	
336	Paliyur	,, 1	10 56 0	78 10 10	4 50	,, 0 50	0·3780	
337	Tanjore	10/18 1	10 46 40	79 8 20	4 0	,, 0 40	0·3815	
338	Máyavaram	11/20 8	11 5 50	79 38 30	5 0	,, 0 15	0·3835	
339	Tirutturaippúndi.	11/20 2	10 32 20	79 38 10	3 35	,, 0 30	0·3820	

Abstract showing the Approximate Magnetic Values at Stations observed at by No. 26 Party during Season, 1902-03—concld.

Serial No.	Name of Stations.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C. G. S.	
340	Állappákkam	13/24 7	11 37 10	79 43 10	6 15	W 0 40	0·3845	
341	Villupuram	,, 5	11 56 40	79 29 50	6 25	E. 0 0	0·3775	
342	Pondicherry	,, 6	11 56 0	79 49 50	7 15	W 0 30	0·3840	
343	Tandara	,, 4	12 6 40	79 9 0	7 10	,, 0 25	0·3815	
344	Polur	,, 3	12 30 50	79 7 50	7 25	E 0 5	0·3805	
188	Kátpádi	,, 1	12 58 40	79 7 40	9 20	W 0 15	0·3840	
345	Chingleput	,, 2	12 41 20	79 58 30	8 5	,, 0 25	0·3825	
185	Ranigunta	14/26 3	13 38 0	79 30 50	10 40	,, 0 5	0·3810	
346	Gudur	,, 1	14 8 40	79 51 10	11 55	E 0 0	0·3830	
347	Pákala	,, 4	13 27 0	79 7 20	9 40	W 0 5	0·3820	
348	Kalikiri	14/28 8	13 38 40	78 47 40	10 40	,, 0 15	0·3825	
349	Tummanamgutta	,, 7	13 42 50	78 21 30	11 15	,, 0 10	0·3830	
350	Kadiri	,, 5	14 6 50	78 9 0	12 0	,, 0 10	0·3815	
351	Dharmavaram	,, 3	14 25 20	77 42 40	12 55	,, 0 10	0·3800	
352	Malugur	,, 6	13 54 0	77 32 50	11 45	E 0 10	0·3775	
353	Thondebhari	,, 9	13 30 10	77 31 0	10 35	W 0 15	0·3825	
354	Garladinne	,, 1	14 50 0	77 35 20	12 55	E 0 10	0·3815	
181	Guntakal	15/27 4	15 10 20	77 22 40	14 40	,, 0 15	0·3805	
355	Bellary	15/29 2	15 8 50	76 55 30	14 5	W 0 5	0·3770	
356	.....	...	...	...	...	...	...	
357	Mangi	30/28 2	30 22 0	67 28 10	42 55	E 2 50	0·3240	
358	Sáiyad Hamid	30/29 2	30 35 20	66 43 20	43 10	,, 2 50	0·3230	
359	Chaman	,, 1	30 56 10	66 25 20	43 50	,, 2 40	0·3210	
360	Abigum	30/32 4	29 48 10	67 23 10	42 5	,, 2 40	0·3265	
361	Spintingi	,, 3	29 55 50	68 4 50	42 15	,, 2 40	0·3270	
362	Gházi Ghat	30/8 5	30 4 50	70 51 50	42 30	,, 2 45	0·3305	
363	Dairadin Panah	,, 2	30 34 10	70 53 30	43 30	,, 2 45	0·3270	
364	Dorala	31/7 6	31 5 10	70 55 30	44 15	,, 3 5	0·3250	
365	Bhakkar	31/8 11	31 37 10	71 3 0	45 0	,, 3 5	0·3225	
366	Shah Alam	,, 9	31 58 40	71 9 0	45 25	,, 3 20	0·3205	
367	Kaleke	31/10 10	31 58 20	73 36 20	45 40	,, 3 10	0·3235	
368	Chiniot Road	,, 11	31 34 20	73 10 40	44 55	,, 2 55	0·3255	
369	Gojra	31/12 12	31 8 40	72 40 30	44 15	,, 3 0	0·3265	
370	Darkhana	30/7 9	30 39 50	72 11 10	44 35	,, 2 45	0·3285	

Repeat Stations.

I	Udaipur	24 35 33	73 41 57	33 15	E 1 30	·3540
II	Kurrachee	24 49 50	67 2 2	33 35	,, 1 40	·3475
III	Quetta	30 11 52	67 0 20	42 35	,, 2 50	·3250
IV	Bahawalpur	29 23 27	71 40 37	41 35	,, 2 50	·3335
V	Rawalpindi	33 35 16	73 3 6	47 45	,, 3 40	·3140
VI	Bharatpur	27 13 31	77 29 28	33 15	,, 2 5	·3470
VII	Bangalore	12 59 35	77 35 58	9 15	W 0 15	·3815
VIII	Dharwar	15 27 26	74 59 35	14 45	0 0	·3765
IX	Porbandar	21 38 20	69 37 6	28 10	E 1 15	·3610

N.B.—Barrackpore Observatory to be plotted.

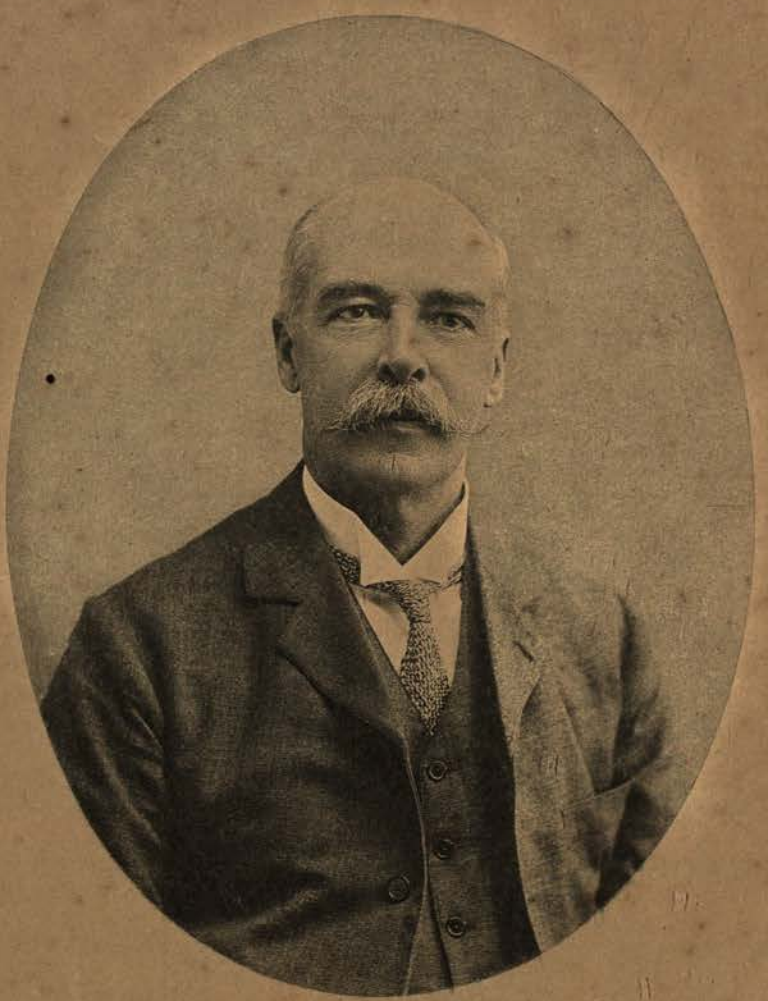
Note.—The above value of Dip, Declination and Horizontal Force are uncorrected for secular change, diurnal variation, astrumental differences, etc., and are to be considered as preliminary values only.

* Where blanks occur, values have been already found during field season, 1901-02, or the observations have not been completed.

The Survey numbers refer to the published chart: thus No. 13/24 3 denotes No. 3 Station in the dotted square, the spherical co-ordinates of whose centre are 26° North Latitude and 76° East Longitude.

All Longitudes are referrable to that of Madras Observatory taken at the value, 80° 14′ 47″ East from Greenwich.

G. I C. P. O.—No. 155 C. G.—4-6-04.—450.—C. M. W



Photogravure. Survey of India Offices, Calcutta, February 1904.

St. G. Gore

From a negative by Messrs Bourne & Shepherd.

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1903-04.

PREPARED UNDER THE DIRECTION OF

COLONEL J. R. HOBDAY, I.A.,
OFFICIATING SURVEYOR GENERAL OF INDIA.

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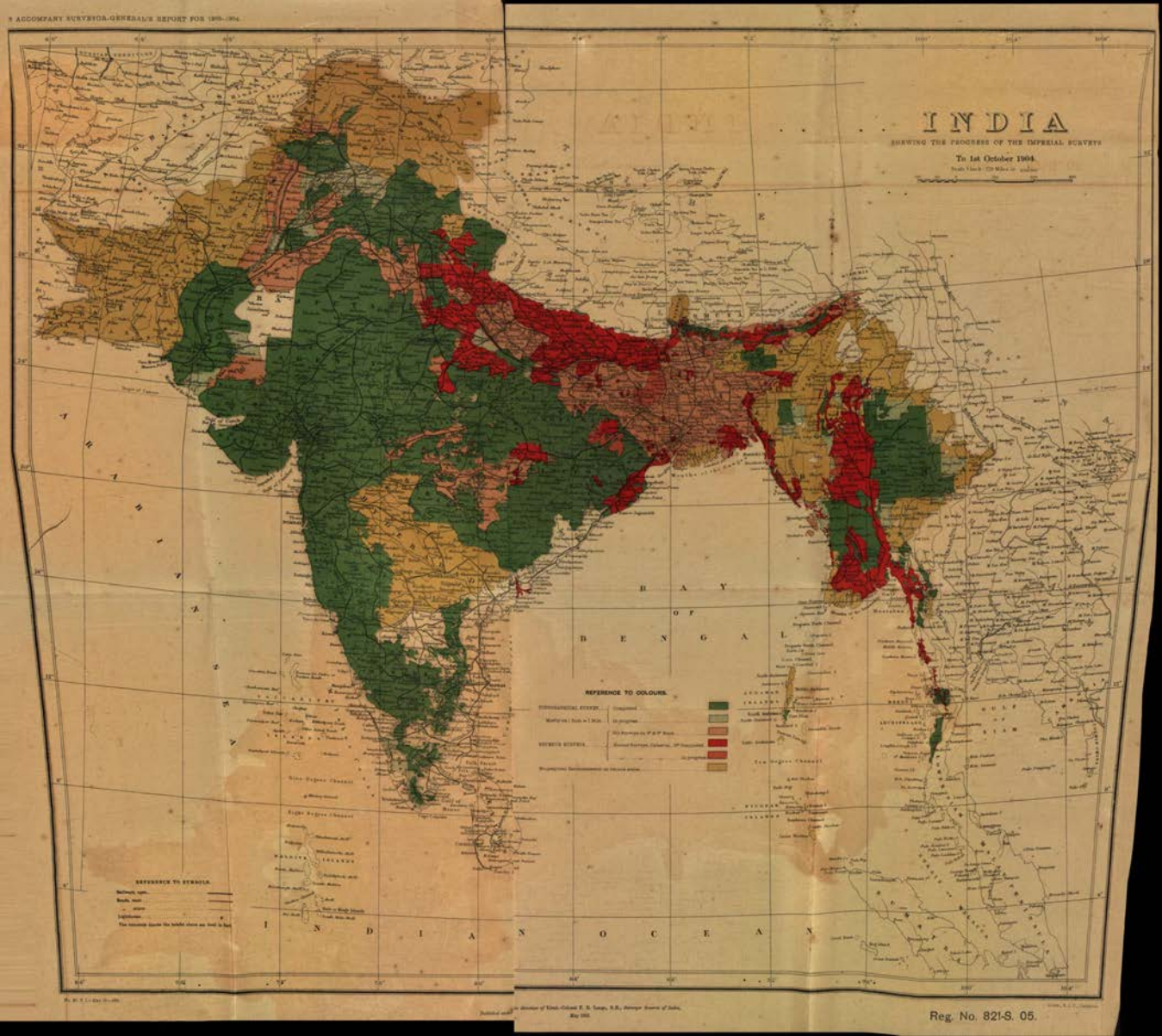
INDEX CHART
TO THE
GREAT TRIGONOMETRICAL SURVEY
OF
INDIA
ARABIAN SEA
BAY OF BENGAL
CEYLON


INDIA
SHEWING THE PROGRESS OF THE IMPERIAL SURVEYS
To 1st October 1904.
REFERENCE TO COLOURS.
REFERENCE TO SYMBOLS.
B A Y
O F
B E N G A L
I N D I A N O C E A N

Reg. No. 821-S. 05.

GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1903-1904.

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PART I.

SUMMARY.

ADMINISTRATION.

1. The operations that are now reported on are for the survey year ending 30th September 1904.

2. Colonel St. G. C. Gore, C.S.I., R.E., Surveyor General, directed the administration of the department up to 23rd February 1904, when, on his retirement, Lieutenant-Colonel F. B. Longe, R.E., succeeded him.

3. The office of the Deputy Surveyor General was held by Colonel J. R. Hobday, I.A., throughout the year.

4. Mr. J. Eccles, M.A., officiated as Superintendent, Trigonometrical Surveys, up to 3rd November 1903, when Major S. G. Burrard, F.R.S., R.E., returned from furlough and resumed charge.

5. Major P. J. Gordon, I.A., held charge of the office of the Superintendent, Forest Surveys, Bengal Presidency, up to the 6th November, when he proceeded on a year's combined leave, Major C. W. H. Symonds, I.A., officiating for the remainder of the year.

On the 1st April 1904, all Forest Surveys in India were amalgamated and placed under the superintendence of one officer as Superintendent, Forest Surveys, having position and powers similar to those of the Superintendent, Trigonometrical Surveys. The Forest Survey Branch thus constituted, consists at present of 4 survey parties, uniformly governed by the rules and regulations of the Survey of India. The Head-Quarter Office of the Branch at Dehra Dún will continue to keep up the map records of the Forest Department and will prepare such special maps as may be sanctioned by the Inspector General of Forests; it will also store and issue all Forest Survey maps. It is hoped that uniformity in standard and system will be secured by amalgamation. The cost of all Forest Surveys on scales of not less than 4 inches to the mile, will be distributed in the proportion of 30 per cent. to topographical survey, and 70 per cent. to Forests.

By a resolution of the Government of India, Revenue and Agricultural Department (Forests), No. 3—213-5-F., dated 11th February 1904.

Inspection tours of Administrative Officers.

6. Lieutenant-Colonel Longe, R.E., Surveyor General, left Calcutta on the 11th April for Simla, stopping on the way to inspect the offices of the Superintendent, Trigonometrical Surveys, and the Superintendent, Forest Surveys, at Dehra Dún. He reached Simla on 30th April, and during his stay there,

inspected the recess office of No. 18 Party on several occasions. He left Simla on the 16th July and arrived at Dehra the following day, and again inspected the offices of, and discussed various questions with, the Superintendent, Trigonometrical Surveys, and the Superintendent, Forest Surveys, finally re-arranging the programme of the Forest Surveys. On the 21st July, he proceeded to Mussooree and inspected the offices of Nos. 14 and 15 Parties, the North-West Frontier drawing office and the parties under the administration of the Deputy Surveyor General and Superintendent, Trigonometrical Surveys, located in that station. On the 6th August, he returned to Dehra and next day proceeded to Naini Tal where he inspected the office of the Superintendent, Provincial Surveys, United Provinces, and the drawing office located there, and returned to Calcutta on the 15th August. He had intended going to Bangalore and Póona to inspect the various survey parties and drawing offices at those stations, but was compelled to abandon this trip and to return to Simla on the 24th September to settle the programme of riverain surveys in the Punjab, in consultation with the Local Government and to discuss various other matters with the Government of India.

7. Colonel J. R. Hobday, I.A., Deputy Surveyor General, left Calcutta on 11th October for Nagpur to discuss survey matters with Mr. Sly, Settlement Commissioner, Central Provinces. He then proceeded to Saugor to inspect No. 1 Party in the field, and thence to No. 14 Party at Cawnpore, returning to Calcutta on 25th October. On 7th February, he proceeded to Burma to inspect Nos. 3 and 7 Parties in the field at Prome and Shwebo. He also interviewed the Settlement Commissioner at Kyauksè, and the Revenue Secretary at Rangoon, and returned to Calcutta on the 10th of March. On 17th May, he visited Darjeeling to attend a meeting of the Bengal Board of Revenue to discuss the question of forming 3 survey parties in that Province in lieu of the numerous detachments, and also to frame rules regarding the preservation of village trijunction marks. He returned to Calcutta on the 31st May. On 8th June, he proceeded to Simla to discuss with the Surveyor General various questions regarding the organisation of the department, and the work connected with No. 18 Party, and returned to Calcutta on the 7th July. On 16th July, he proceeded to Dehra and from thence on the 20th to Mussooree, where he accompanied the Surveyor General in inspecting the offices of the several survey parties recessing there. From Mussooree, he accompanied the Surveyor General to Naini Tal and inspected the United Provinces drawing office, and returned to Calcutta on the 15th August. On 28th August, he proceeded to Rajahmundry to inspect the Godávari detachment, and from thence to Bangalore where he organised the Training School, and inspected Nos. 3, 10, 11, and 19 Parties and the Bangalore drawing office. On the 27th September, he continued on to Poona where he inspected No. 17 Party, and from thence to Amráoti in Berar, where he visited No. 2 Party, which had just been formed, and finally returned to Calcutta on 8th October. During the year under report he visited the Bengal drawing office in Calcutta on several occasions.

8. Major S. G. Burrard, R.E., Superintendent, Trigonometrical Surveys, visited Kurrachee in April 1904, and inspected No. 12 Party; in June he inspected No. 22 Party; visited Mussooree in August and September and inspected Nos. 23, 24 and 26 Parties and the levelling detachment of No. 25 Party. He inspected in Dehra Dún No. 25 Party and the Survey Training School during the year from time to time.

9. Major Symonds, I.A., Officiating Superintendent, Forest Surveys, inspected the detachments of No. 9 Party working in Assam, Burma and Bengal, and No. 20 Party in the field. He also inspected the recess offices of No. 17 Party at Poona, No. 19 Party at Bangalore, and No. 20 Party at Dehra Dún.

DISTRIBUTION OF FIELD PARTIES.

10. During the year under report the double parties were separated. The parties formerly known as Nos. 2 and 8 and Nos. 9 and 19 are now designated Nos. 8 and 19, respectively. A new party, No. 2, working in Berar has been formed for the training of junior Imperial and Provincial officers, whilst scattered detachments employed on Forest Surveys have been amalgamated to form No. 9 Party. In Bengal the several detachments employed on cadastral and traverse

survey operations will next year be combined to form Nos. 5 and 6 Parties. The designation of Nos. 11 and 21 Parties has also been changed to No. 11 Party.

Field operations were carried on by 20 parties and 8 detachments; of these 8 were employed on topographical surveys, 4 on forest surveys, 3 parties and 8 detachments on cadastral and traverse surveys, 1 on triangulation and 4 on scientific operations.

In the following statement the whole of the operations are grouped according to the nature of the work on which the parties are employed:—

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
	Topographical.			Inch. Miles.	
1	Central Provinces	19	Mr. R. C. D. Ewing Captain A. H. B. Hume, R.E.	2 = 1	D. S. G.
3	Lower Burma	20	Mr. E. F. Litchfield „ P. J. Doran	1 = 1	Ditto.
10	Upper Burma	21	Captain F. W. Pirrie, I.A. Lieutenant A. A. McHarg, R.E. Major J. M. Burn, R.E. Captain C. P. Gunter, R.E.	1 = 1	*Ditto.*
11	Ditto	22	Major J. M. Burn, R.E. Captain C. P. Gunter, R.E. Mr. P. J. Doran	1 = 1	S. G.
12	Sind	23	Mr. C. F. Erskine Lieutenant E. T. Rich, R.E. Mr. G. G. Vander-Beek	2 = 1	Supdt., Trig.
14	United Provinces	24	Major C. W. H. Symonds, I.A. Captain H. L. Crosthwait, R.E.	2 = 1	S. G.
15	North-West Frontier	25	Captain F. W. Pirrie, I.A. Mr. E. A. Wainright	Various	S. G.
18	Punjab	26	Captain E. A. Tandy, R.E.	Do.	S. G.
	Forests.				
9	Bengal Assam Punjab North-West Frontier United Provinces Central Provinces Burma	28	Major P. J. Gordon, I.A. „ C. W. H. Symonds, I.A.	4 = 1	
17	Bombay Presidency	29	Mr. B. G. Gilbert-Cooper	4 = 1 8 = 1	Supdt., Forest Surveys.
19	Madras	31	Captain C. L. Robertson, R.E. Mr. G. T. Hall	4 = 1	
20	Burma	33	Captain A. Mears, I.A.	4 = 1	
	Cadastral and Traverse.				
4	Bengal and 6 detachments	35	Major R. T. Crichton, I.A. Captain F. C. Hirst, I.A.	16 = 1	D. S. G.
7	Burma	40	Lieutenant-Colonel G. B. Hodgson, I.A. Captain C. P. Gunter, R. E.	16 = 1	Ditto.
8	United Provinces	42	Captain W. M. Coldstream, R.E.	16 = 1	Ditto.
	Godávari detachment	45	Mr. S. F. Norman, (Jr.)	16 = 1	Ditto.
	Assam detachment	46	„ T. Shaw	.....	Ditto.
	Trigonometrical.				
24	India (Triangulation)	47	Captain H. Wood, R.E. „ H. H. Turner, R.E.	.....	Supdt., Trig.
	Scientific.				
22	India (Latitudes)	48	Major S. G. Burrard, R.E. Captain H. M. Cowie, R.E.	.....	Ditto.
23	Do. (Pendulums)	49	Major G. P. Lenox-Conyingham, R.E.	.....	Ditto.
25	Do. (Tidal and Levelling)	51	Captain H. H. Turner, R.E.	.....	Ditto.
26	Do. (Magnetic)	53	Captain H. A. D. Fraser, R.E. Lieutenant R. H. Thomas, R.E.	.....	Ditto.

OUTTURN.

11. The total outturn of detail survey during the year amounts to 58,464 square miles, which includes 24,100 square miles of geographical surveys. The area surveyed during the previous year amounted to 70,797 square miles which included a geographical survey of 38,000 square miles. The total area triangulated is 22,496 square miles against 15,223 last year. The total area traversed for cadastral purpose is 8,720 square miles *viz.*, 3,181 square miles in the United Provinces, 4,545 square miles in Bengal, 859 square miles in Burma and 135 square miles in Madras.

TOPOGRAPHICAL SURVEYS.

12. During the year under report no changes of the *locale* of operations of the topographical survey parties have taken place, the work being carried on in continuation of that of previous seasons.

13. *Punjab.*—No. 18 Party continued the supplementary surveys in the Province, on the 2-inch scale, utilising and verifying the detail as obtained from reductions of the *patwári* village maps. An area of 2,669 square miles was thus completed in Multán district, and 421 square miles in Amritsar.

The progress of these much needed surveys was considerably hampered and curtailed, owing to the necessity for carrying on riverain surveys for the Local Government; also a portion of the staff of this party was engaged in completing and mapping the large scale survey of Simla. Similar supplementary surveys are urgently needed in districts Gurdáspur, Gujránwála, Siálkot, Gujrát, Shahpur, Jhang, and Muzaffargarh, and unless another survey party is shortly sent to the Punjab, it will be impossible to bring out topographical maps of this vast area, within a reasonable period.

14. *United Provinces of Agra and Oudh.*—No. 14 Party topographically surveyed on the 2-inch scale, an area of 1,936 square miles in districts Allahabad, Fatehpur, and Cawnpore, and 285 square miles of supplementary survey in districts Partabgarh and Rae Bareli to complete standard sheets up to graticule limits.

15. *Central Provinces.*—No. 1 Party completed the supplementary topographical survey on the 2-inch scale of an area of 2,839 square miles in districts Saugor and Damoh, including a forest area of 526 square miles which had been previously surveyed on the 4-inch scale, and which material was utilised and incorporated. A small area of 35 square miles in Gwalior, Bhopal and Panna falling in the standard sheets, was also surveyed.

An area of 1,722 square miles was triangulated in Berar, the detail survey of which will be commenced next field season, by a new party that will be formed for the training of junior Imperial and Provincial officers.

16. *Sind.*—An area of 2,715 square miles was topographically surveyed on the 2-inch scale by No. 12 Party in this Province.

17. *Baluchistan.*—An area of 1,287 square miles was topographically surveyed by No. 15 Party.

18. *Burma.*—An area of 2,148 square miles of topographical survey on the 1-inch scale was completed by No. 3 Party in districts Thayetmyo, Magwe, and Minbu, and 455 square miles of supplementary survey of such parts as had been previously cadastrally surveyed.

An area of 2,704 square miles of supplementary survey on the 1-inch scale was completed by No. 10 Party in districts Shwebo, Sagaing and Lower Chindwin, and 301 square miles of new topographical survey.

An area of 3,153 square miles of topographical survey on the 1-inch scale was executed by No. 11 Party in the Shan States of Nonglün, Kēng Tung, and Möng Pan.

19. The total outturn for the year under the head of new topographical survey and supplementary survey on the 1-inch and 2-inch scales, amounts to 20,948 square miles as follows:—

	Square miles.
Punjab	3,090
United Provinces	2,221
Central Provinces	2,839
Gwalior, Bhopal and Panna	35
Sind	2,715
Baluchistan	1,287
Burma	8,761

FOREST SURVEYS.

20. The forest survey operations during the year were generally in continuation of those of the previous season, and were under the administrative charge of the Superintendent of Forest Surveys.

21. In Madras No. 19 Party continued the detail survey on the 4-inch scale of the forests in the Godávari, Kistna, South Canara, and Kurnool districts, and the 4-inch revision survey in North Coimbatore. Triangulation was also carried out in Godávari, Chingleput, Trichinopoli, South Canara and North Malabar.

An area of 803 square miles was surveyed on the 4-inch scale at a cost of R102 per square mile, as compared with an area of 1,411 square miles at R58 per square mile in 1902-03. The increase in the rate is regrettable but unavoidable, owing to the very unhealthy season throughout the Presidency, more especially in the Godávari district where the entire camp lost a month's outturn through sickness. In South Canara the forests were mostly in detached blocks, which always entails loss of time and area. In addition to the above-mentioned causes labour difficulties, floods, want of water, and the extremely difficult nature of the country under survey, combined to affect the outturn, and hence the cost-rates, in an adverse manner. There was also a considerable increase in the pay of the executive officer during the year.

22. In Bombay, forest surveys on the 4 and 8-inch scales were carried out in the Násik, Khándesh, Sátára and Thána districts. A survey of Mátherán hill station on the 16-inch scale was also completed.

Six hundred and seventy-seven square miles were triangulated and 576 square miles topographically surveyed on the 4-inch, and 158 on the 8-inch scale, as compared with 487 and 240 in 1902-03. The cost-rates were slightly higher than for the previous season, being R67 and R139 for 4-inch and 8-inch detail survey as compared with R61 and R130 in 1902-03.

The season, as in Madras, was unhealthy and there was much sickness among all ranks. The necessity for moving the camps from the healthier districts, where they are employed at the commencement of the season, to the unhealthy districts in the hot weather helps to add to the cost. The fact of less than two of the best surveyors of the party having been employed on the survey of Mátherán for nearly the whole of the season affected the outturn and, therefore, the cost-rates of the forest work. The increase, however, is a small one.

23. In Burma an area of 671 square miles was surveyed on the 4-inch scale by No. 20 Party in the Upper and Lower Chindwin, Pakôkku, and Thayetmyo districts. A large area was also triangulated and traversed in advance in the same districts. The cost-rates were practically the same as for last year, being R44 per linear mile for traversing, and R136 for 4-inch detail survey. The cost of triangulation was R7·4 as compared with R3·2, per square mile. Compared by the fairest test, *i. e.*, the number of stations of observation, the rate for this current season is more favourable than for last year. The rate for detail survey remains high owing to the difficult nature of the country under survey, and to the large expenditure in connection with the transport of the party from India to the Chindwin valley, and the unproductive time occupied on the journey.

24. The forest survey detachments, now known as No. 9 Party, were employed in Burma, Assam, Bengal, the United Provinces and the Punjab.

Two detachments working in the Mandalay, Katha, Shwebo, and Ruby Mines districts surveyed an area of 447 square miles on the 4-inch scale at a cost-rate of R91 per square mile, as compared with R64 in 1902-03. An area of 800 square miles was triangulated and 1,159 linear miles were traversed in advance; the cost-rates were R9 per square mile for triangulation, and R13 per linear mile for traversing, as compared with R10 and R37 respectively in 1902-03. The decrease in cost-rates for traversing and the increase in those of detail survey, are due entirely to the nature of the country under survey. As already explained in former reports, the cost-rates of these detachments cannot well be compared with those of No. 20 Party, the conditions being dissimilar.

In Assam, a detachment was employed in the survey of the forests in the Gáro hills, Kámrúp and Nowgong; nearly 1,000 square miles were triangulated, 286 linear miles traversed, and 160 square miles surveyed on the 4-inch scale. The rates of all classes of survey in Assam were considerably reduced, that of detail survey being R85 as compared with R98 in 1902-03.

Considering the difficulties in connection with labour and transport, the flooded tracts encountered in the area surveyed, and the cost of transporting the detachment to and from the field, the results may be considered satisfactory.

In Bengal, besides triangulation and traversing, 219 square miles were surveyed on the 4-inch scale in Darjeeling and Kalimpong, and 91 square miles in Singhbhum, completing the surveys in these districts. The cost-rates were practically the same as for last year.

In addition to the operations detailed above small detachments were employed on the outline survey of the Jhelum and Lahore forests, the completion of the survey of the Naini Tal reserves, and on preliminary triangulation in the Hazára district.

25. The total outturn of forest surveys on various scales during the year amounts to 3,375 square miles.

Nearly two-thirds of the total gazetted forest area in India or 62,533 square miles, have now been surveyed on the 4-inch and larger scales for forest purposes.

CADASTRAL AND TRAVERSE SURVEYS.

26. During the year under report there was one cadastral party in the United Provinces of Agra and Oudh, one in Bengal with 6 detachments, one in Burma and one small detachment in Madras.

27. In the United Provinces 270 square miles were traversed in the Moradabad district, and 507 square miles surveyed cadastrally with records in the Amroha, Moradabad and Thákurdwára *tahsils* of the same district. The old cadastral maps and records were corrected in the Amroha *tahsil* of Moradabad, in the Bánda and Pailáni *tahsil* of Bánda, and in the Hamírpur, Sumerpur and Maudha *parganas* of Hamírpur, covering an area of 1,488 square miles. The following towns were surveyed for municipalities :—Muttra, Brindaban, Tánda Khas, Barehta (Fyzabad). In the two former, the open ground was surveyed on the 16-inch scale, but in the others the whole area was done on the 64-inch scale.

Surveys on the scale of 64 inches=1 mile, showing the boundaries and adjacent detail of 1,125 linear miles of 1st class roads in the Meerut and Lucknow divisions, were carried out for the Public Works Department.

No. 14 Party also demarcated and traversed 2,911 square miles in districts Fatehpur and Cawnpore.

28. In Bengal 5,028 square miles were traversed, 4,054 square miles were surveyed cadastrally, and the records were written of 4,065 square miles in the Midnapore, Bhágalpur, Purnea, Backergunge, Ranchi and Singhbhum districts. An area of 463 square miles of the beds of the Ganges and Kosi rivers, was surveyed topographically on the scale of 4 inches to the mile. The survey of the suburbs of Calcutta was continued in conjunction with that of the Panchannagram Government estate and also those of the municipalities of Bhágalpur, Monghyr and Roserha (Darbhanga).

29. In Burma, 859 square miles were traversed, and 818 square miles cadastrally surveyed in the Pakôkku and Shwebo districts.

30. In the Central Provinces the traversing of Forest excisions and scattered villages for local agency survey was continued. The area traversed is 41 square miles scattered over 5 districts.

31. In Assam, 91 square miles of tea grants were traversed, and 4 square miles for cadastral survey by local agency.

32. In Madras the survey of the Godávari delta for the Irrigation Department was completed, the outturn during the season being 135 square miles of traversing, cadastral survey and record-writing.

33. The total areas traversed and cadastrally surveyed are as follows :—

Province.	Traversing, Square miles.	Cadastral survey, Square miles.
United Provinces	3,200	2,000 (*a*)
Bengal	5,028	4,054
Burma	859	818
Central Provinces	41	...
Assam	95	...
Madras	135	135
TOTAL	9,358	7,007

(*a*) Includes 1,488 square miles of map correction, and 5 of town surveys.

TRIGONOMETRICAL SURVEYS.

34. The programme of the triangulation party (No. 24) was to continue the Great Salween series southwards, but this was interfered with by the deputation of Captain Wood, R.E., to Nepal to investigate the identity of Mount Everest with a peak called Gaurisankar. When he returned in December, the season for observation in Burma was so far advanced that it was considered advisable to alter the programme and employ Captain Wood in observing geodetic azimuths at some of the longitude stations in India and Burma. The Provincial officers of the party were engaged during the field season in building stations for the Great Salween series extending as far south as latitude 20° 30′.

SPECIAL OPERATIONS.

35. Captain Wood was employed at the commencement of the field season in identifying the Himalyan peaks seen from Kátmándu. By the time that he had completed this important work, it was too late for him to commence trigonometrical operations in Burma, and as no other officer was available, the principal triangulation of Burma was not continued. Work on the Great Salween series of principal triangulation will, however, be resumed as soon as opportunity offers, as it is required to determine the terrestrial position of the eastern boundary of Burma.

36. On finishing his work in Nepal, Captain Wood with No. 24 Party, proceeded to observe rigorous astronomical azimuths at longitude stations in India and Burma. These azimuthal observations are required for the determination, by means of Laplace's equation, of the errors accumulated in the principal triangulation.

37. Captain Cowie in charge of No. 22 Party, extended the triangulation of the Great Arc of India northwards for a distance of 35 miles into the hills, and observed for latitude at stations in the heart of the Himalayas.

38. Pendulum observations were commenced this year with a new apparatus, and their progress is being watched with interest by European geodesists. The International Conference that met at Copenhagen in 1903, discussed the questions which were raised in the Survey of India Professional Paper No. 5 of 1901, concerning the deflections of gravity in northern and central India, and passed a resolution on the subject to the effect that the Indian plumb line determinations required to be supplemented by new observations of the pendulum, and that in no other way could the deformations of the geoid and the variations in the density of the earth's crust be definitely measured. After studying the use of the instrument at Potsdam, and observing with it at Kew and Greenwich, Major Lenox-Conyngham brought the new pendulum apparatus to India, and commenced determinations of the force of gravity in this country.

39. Tidal operations were continued by No. 25 Party, observations being recorded at 12 stations. The observatory at Okha in Cutch was opened during the year. Levelling operations were extended in Upper Burma.

40. Five detachments of No. 26 Party continued and extended the field work of the magnetic survey over different portions of the country. Four of the five base stations are now working, and it is hoped that Toungoo, the fifth, will be installed during 1904-05.

GEOGRAPHICAL SURVEYS.

41. Under this head are included surveys and reconnaissances which are executed on the $\frac{1}{2}$-inch and smaller scales.

The survey detachment with the Aden Boundary Mission completed an area of 3,600 square miles on the $\frac{1}{2}$-inch scale, and 2,500 square miles on the $\frac{1}{4}$-inch scale. A narrative report of this work from the date of its commencement in 1901, will be found in the appendix.

The survey detachment with the Seistan Mission also completed about 15,000 square miles on the $\frac{1}{4}$-inch scale during the year 1904.

Another detachment accompanied the Tibet Mission, and completed an area of about 18,000 square miles of the country between British territory and Lha-sa. Captains Ryder and Wood, R.E., also returned from Gyang-tse *viâ*

Shi-ga-tse and Gartok to Simla and added another 40,000 square miles of geographic alsurvey of much interest.

HEAD-QUARTERS OFFICES, CALCUTTA.

42. The general direction of these offices remained under Colonel St. G. C. Gore, C.S.I., R.E., up to 23rd February 1904, and thereafter under Lieutenant-Colonel F. B. Longe, R.E. The Deputy Surveyor General's Office was also located, as usual, in Calcutta. The Suveyor General's Office was under Major J. M. Burn, R.E., up to 5th June 1904, and thereafter under Bt.-Lieutenant-Colonel T. F. B. Renny-Tailyour, R.E. The Drawing, Engraving and Map Record and Issue offices were under Major J. M. Fleming, up to 14th April 1904, when he proceeded on leave, and Major W. J. Bythell, R.E., took charge from the 3rd May 1904. The Photo-Litho Office was under Mr. T. A. Pope throughout the year. The Mathematical Instrument Office was under Major J. M. Burn, R.E., up to 5th June 1904, and thereafter under Bt.-Lt-Colonel T. F. B. Renny-Tailyour, R.E. Lieutenant C. M. Browne, D.S.O., R.E., remained attached to the Mathematical Instrument Office up to 31st July 1904.

43. *Drawing Office.*—The "General Section" has, as usual, been engaged throughout the year on the compilation and revision of the "general" maps and the addition of new material to all standard sheets of which reprints and new editions are required. A large number of sheets received for publication from the various field parties have been scrutinized and prepared for press.

Ten "general" maps of India, on scales varying from 32 miles to 256 miles to the inch, have been in progress during the year, of which 5 are new editions. Of these the new 32 and 64 mile maps have been delayed for a very considerable period, owing to the difficulty of obtaining the correct alignment of boundaries of the North-West Frontier Province from the local authorities. These boundaries can only be considered as approximate, as they are not from actual survey.

Sixteen sheets of $\frac{1}{1,000,000}$ "map of India and adjacent countries" have been in hand during the year, and 13 of these are under publication.

Thirty maps of Provinces, chiefly on the scale of 16 miles=1 inch, [illegible] which those of Bengal, Madras and Bombay have been in progress during the year, of which [illegible] are new publications.

Forty-four "District" maps on the $\frac{1}{4}$-inch scale have been brought up to date or completed, 20 of which have been published.

Two hundred and thirty-six "standard sheets" on the scale of 1 inch=1 mile have been in hand. Of these 97 have been published, (29 being new publications and 27 new editions). Forty-four more are under publication, 2 are of the Andamans, 14 of Bengal, (of which 4 have been drawn in this office), 28 of Bombay, 31 of Burma, 72 of Central India and Rájputána, 4 of the Central Provinces, 8 of Madras, 6 of the North-East Frontier, 2 of the Northern Trans-Frontier, 46 of the North-West Trans-Frontier, 1 of the Punjab, 6 of the South-East Frontier and 1 of South-West Asia. The remarks contained in last year's report concerning the difficulty of reconciling these separate surveys when compiling new standard sheets still hold good.

Twelve Burma "Forest" maps have been brought up to date and published.

Twenty-one "Administration Report" maps have been brought up to date and published, 2 are in hand and 3 under publication.

Four of the Burma "Degree sheets" on the scale of 1 inch=4 miles have been in hand during the year, 1 has been published, 2 are under publication, and 1 is under compilation.

Eighteen "Index" maps on various scales have been brought up to date and published, 4 triangulation charts are in hand, 1 is under publication and 4 have been published.

A large number of plans of cities and cantonments, aggregating 76 sheets, all on large scales of survey, have been dealt with: of these 14 sheets are in hand, and the remainder have been brought up to date and published.

44. In the "Colouring Section," 2,523 sheets have been coloured during the year.

The demands for "extra departmental" work have as usual been very large, entailing considerable delay in the legitimate work of the office, which is the compilation of, and bringing up to date of, the "general" and "standard" maps. It has been found impossible to deal with more than a small number of the standards as reprints of sheets out of stock, and these arrears continue to increase; nor will this state of affairs improve until either the staff is very materially increased, or the present staff is entirely relieved of all "extra departmental" work.

The large "Postal" maps of Provinces on the 8-mile and 4-mile scale, have taken up the time of 3 or 4 draftsmen continuously throughout the year. Of these the maps of Bengal and Berar have been completed and are under publication, whilst that of the United Provinces is in progress. In all some 101 sheets of purely "extra departmental" work have been dealt with.

45. In the "Examining Section," 3,068 sheets have been passed, and a large amount of "miscellaneous" work, such as the supply of data, examination of proofs, spelling, computation of graticules, etc., has been carried out, whilst the revision of the Gazetteer has involved much labour in the supplying of correct geographical positions of towns, villages, limits of fiscal divisions, lengths of rivers, etc.

46. In the "Revenue Section," 387 standard sheets have been dealt with. Of these, 148 in 430 sections are new sheets received from parties and sent for publication, the greater number being received from the Punjab and United Provinces parties. Of the total number of standard sheets dealt with, 137 were new publications, 51 new editions, and 199 reprints.

With a view to expediting the publication of Bengal standard sheets from the old fragmentary surveys, (a work much in arrears as few such sheets at present exist) sanction was accorded to the formation, for a year from 1st June, of a small "arrears section," consisting of 1 retired Provincial officer and 10 draftsmen. Owing to the impossibility of obtaining trained draftsmen on the low pay allowable in Calcutta, it was found necessary to entertain some of the unpaid apprentices then working in the Drawing Office. The progress of these youths is painfully slow. However, during the period, *i.e.*, from 1st June to the close of the survey year, 13 standard sheets of Bengal have been taken up and are in various stages of progress, 2 having been sent to press. 6 sheets of Assam were also in hand, of which 4 have gone to press, and 1 of the Punjab is ready for press. It is hoped that, with increased experience, the work of this section will steadily improve both in quality and quantity.

The "special" maps to show the Nepal boundary along the Sárda river, mentioned in last year's Annual Report have been published, and the final proofs received from the Foreign Department have been sent for approval to the Nepal Durbar, but have not yet been received back.

The usual revision work has been carried out on "Index" maps, 1 new one having been prepared. 1,262 pages of traverse have been copied and examined to comply with various applications, and a very large amount of "miscellaneous" work, such as preparation of scales, calculation of areas, etc., has been done.

Eighty traces and copies of village plans were prepared for district officials, and the number of applications received for copies of maps etc., from private individuals amounted to 1,268, in response to which 2,154 authenticated copies were issued, the Government fees thereon amounting to ₹1,264.

A total of 32,746 coloured copies of maps have been examined and passed, and 394 pairs of office copies have been prepared, examined and certified, whilst 716 more have received corrections and additions. The plan lately instituted of bringing all the office copies of maps into racks in one room and placing them all under charge of one Provincial officer, will, it is hoped, ensure their preservation, whilst their careful registering will greatly lighten the labour of searching for them when required for reference.

47. *Engraving Office.*—The outturn of work completed by this office is slightly in excess of last year's. 4 new quarter sheets of the Atlas of India Nos. 41 N.-E., 41 S.-E., 50 S.-W. and 78 S.-E., and 2 district maps Wun, Central Provinces and Kámrúp, Assam, on the 8-mile scale, have been published.

A new map of India on the 32-mile scale has been commenced, 2 sheets having been projected and sent for compilation. It has been decided to

complete this map in outline and writing on one set of plates, the hills being engraved on a second set for double printing. The new map on the 64-mile scale is still under compilation. The duplicate plates of the map on this scale have been pushed on as fast as possible, sheet 1 is completed in outline and writing and also sheet 2, the latter being in the hill etchers hands; sheet 4 has only a small portion in the north-west corner to complete it in outline and writing. The heavy corrections necessary to bring the 80-mile railway map up to date have been carried out and a transfer sent to the Photo. Office. The general map, on the same scale, in 2 sheets, is in hand with heavy corrections, to bring it up to date. The new material on the frontiers on the 96-mile map, has been completed and the internal portion is being brought up to date. Both the maps on the 128-mile scale are being brought up to date and the new map, on this scale, which is intended to be used for "administration report" purposes has been completed in outline and the writing commenced. Slight corrections were carried out on the 192-mile map. Both the 256-mile maps, with and without hills, have been in hand with further additions and corrections. 3 new plates for the "Bay of Bengal" and "Bengal daily weather report" have been cut and 2 new "weather charts of India" are being engraved. 9 plates of "India and adjacent countries" on the $\frac{1}{1,000,000}$-scale have been in hand, the Andaman Islands sheets being advanced in writing. Portions of the hills to one of these sheets have been engraved and registered in brown, with the outline and writing in black, and the process promises to be very successful.

Of the maps on the 16-mile scale the corrections on the map of Assam were stopped, as with so many changes, the condition of the present map does not warrant its being further worked upon when the sheets of the $\frac{1}{1,000,000}$ map will soon be available for this part of the country. The 2 sheets of Bengal are having the boundaries and district names cut upon them. Some new material has been cut on the map of the Bombay Presidency, but it still requires further material to complete it. The 2 sheets of Central India Agency have been brought up to date. The map of the Madras Presidency has been completed and is under examination. The map of the Punjab, in four sheets, was ready for publication with the exception of a few external boundaries, but further changes have taken place in the formation of new districts, which will necessitate further corrections to the plates before the map can be issued to the public.

Twenty-eight maps, for administration reports, and 3 index maps were brought up to date.

Sheets 2, 3 and 6 of the 16-inch plan of Calcutta, are being brought up to date. The 6-inch plan has been completed with street names, where it is thought no change is likely to take place, and is now waiting for the list promised by the Municipal Corporation before proceeding further. A 3-inch plan has been put in the hands of the engravers and is well advanced in outline.

Fifty-six new "quarter Atlas sheets," in various stages of progress, were added to; 124 published "quarter sheets," and 29 full sheets have been in hand to bring them up to date before printing, whilst 24 new "quarter sheets" have been projected or had borders cut on them.

Fifty-three miscellaneous plates of scales, conventional signs, and tints for heliogravure have been cut or had titles and foot-notes cut upon them, making a total of 364 plates that have been worked upon during the year.

The three new copper-plate printing presses were in working order by the end of February, and this section has now been placed on a footing able to cope with the demand for engraved maps. It is already beginning to relieve the pressure of demand for maps, but will take some time yet to put the Map Record and Issue office in possession of copies from all the engraved published coppers. The result of the increased number of presses has been an outturn of 47,720 copies. The large number of plates required by this section has put much more work on the "steel facing section" which had to deal with no less than 450 plates.

Twenty-seven plates were corrected and filled in by electro-deposition and the grey effect produced by the silvering process has been overcome, the plates now treated being clean after deposition.

48. *Photographic and Lithographic Office.*—The total outturn of printed copies of maps, plans and diagrams, both for the Survey of India and for other

departments, shows a slight falling off as compared with last year's results, the small difference being accounted for by a considerable reduction in the number of cadastral sheets received for reproduction from Burma. Last year the total number of copies printed both from zinc and stone in the lithographic machines and presses, amounted to 1,032,495. During the year under report the total number was 968,145, or 64,350 less, and it comprises 250,530 copies of departmental maps, as against 186,609 last year; 54,340 copies of cadastral maps, as against 126,203; and 663,275 copies of maps, plans, etc., done for other departments, as against 719,683. It will thus be seen that the decrease in the number of cadastral sheets printed, amounting to 71,863, more than accounts for the total decrease of 64,350 shown under all three heads. The amount of work done for the Survey of India has, it will be seen, increased considerably, while there is a corresponding reduction in the amount done for "extra departmental," purposes. This result, however, is not due to any reduction in the demands made upon the office by other departments, but to the fact that such work has, in many instances, been declined in order that there should be no undue interference with the publication of departmental mapping. The year's working in the other sections of the office shows very satisfactory results, especially in the "heliogravure section," where the number of copies printed from photogravure plates amounted to 86,447, or 25,449 more than last year. A much larger quantity of work was executed by the half tone block process, the number of blocks prepared being 94 or 77 more than last year, the number of copies printed from them being 39,249.

49. In para 54 of last year's report, reference was made to the necessity for more skilled European supervision in the sections engaged on the photozincographic reproduction of maps. Steps have now been taken to remedy this defect, the Government of India having applied to the Secretary of State for the services of two additional European assistants, one to be attached to the "zinc printing section" to relieve the head printer of the whole of the "extra-departmental" work which now occupies so much of his time, and the other to take charge of the "transfer printing section." It is hoped that these men can be obtained from the School of Military Engineering at Chatham, where instruction is given in photozincography and kindred processes to non-commissioned officers of the Royal Engineers, and that they will arrive early in 1905. From this much needed addition to the European supervising staff, it is expected that a decided improvement in the quality of the work turned out will result.

With regard to the quantity of work done, matters remain very much as they were a year ago, and it is still impossible for this office, with its present establishment and plant, to execute all the work demanded from it. If all the "extra-departmental" work received were to be put in hand at once, serious delay in the publication of the Survey of India maps would inevitably ensue. On the other hand, to give precedence in every case to the work of the Survey means, that the work required by other departments, almost always of an urgent nature, has to be taken up so late that it becomes useless for the purpose for which it is intended. These questions will be fully considered by the Survey Committee now sitting, and there can be little doubt that the only solution of them lies in the entire removal of the "extra-departmental" work to some other agency.

The block in the lithographic sections has been to some extent removed by the addition of four new posts for lithographic draftsmen, referred to in para 59 of last year's report, which has enabled the office to execute a larger amount of lithographic drawing for departmental purposes than in any previous year. In order to expedite work in the photographic branch of the office, the Assistant Surveyor General proposes to employ a system of electric illumination of the plan-boards in the "negative section," which he believes will reduce the time occupied in exposing the negatives very considerably, and so enable a larger number of negatives to be turned out daily, especially in dull rainy weather, when the work of the section is often at a standstill for want of light. Two pairs of powerful arc lamps, of the pattern used in England and America for the same purpose, have been included in the annual store indent of the office for 1905-06, and it is hoped that they will be installed before the rainy season of 1905 sets in.

50. In the "Photographic Branch" the following were the more important departmental publications of the year:—

(1) A map of Persia, on the 16-mile scale, in 6 sheets, with hills in brown, photozincographed and 1,800 copies printed.

(2) A map of Aden, on the 8-inch scale, in 6 sheets, with hills in brown, photozincographed and 1,800 copies printed.

(3) Eight sheets of the new $\frac{1}{1,000,000}$ map of "India and adjacent countries," with hills in brown, photozincographed and proofs supplied.

(4) A sketch map of part of Nepal, on the 16-inch scale, reproduced by the Vandyke process and 220 copies printed.

(5) A map of Maymyo and surrounding country, on the 1-inch scale, with hills in brown, photozincographed and 300 copies printed.

(6) 216 standard sheets on various scales, were either photozincographed or reprinted from old plates, of which 39 were in two colours. In addition to these, 16 standard sheets of the Central India and Rájputána survey were reprinted and 5,000 copies on cloth were supplied to the Director of Land Records, Gwalior State.

Among the many items of work executed for other departments either by photozincography or the Vandyke process, the following may be specially mentioned:—

For the Quarter Master General in India, a military traffic map of India, on the 80-mile scale, in two sheets and four colours, was reproduced by the Vandyke process, and 2,400 copies supplied. For the same officer, a district map of India, on the 64-mile scale, was photozincographed and 240 copies printed; and two maps of Korea and Manchuria, each in two sheets, were photozincographed and 1,770 copies supplied.

For the Post Master General, Central Provinces, a postal map of the Province, on the 18-mile scale, in 8 sheets, was photozincographed and a proof supplied.

For the Pakôkku Municipality a wall map of Pakôkku town, in two sheets, was photozincographed and 50 copies supplied.

For Mr. G. W. Forrest's "Selection of State Papers" dealing with the mutiny of 1857, five maps of the city and environs of Lucknow were photozincographed and 1,070 copies of each printed.

For the Linguistic Survey, one language map in four colours and another in three colours were photozincographed, and 1,335 copies of the former and 1,265 of the latter were printed.

In addition to the above a very large amount of miscellaneous work was done for the Public Works, Telegraph and other departments, and for the Military authorities, as usual, a large number of manœuvre maps, on various scales and chiefly in two colours, were either photozincographed or reprinted from existing plates.

51. In the "Lithographic Branch," work on the new 32-mile map of India proceeded continuously throughout the year. The drawing of the entire outline of the six sheets was completed, but a few additions and corrections have still to be made on sheets 3, 5 and 6. The drawing of four of the hill sheets, Nos. 2, 3, 5 and 6, is now complete. One more is in hand and will be completed early in 1905. The map of the Madras Presidency, on the 32-mile scale, which has been in hand, off and on, since 1901, was completed and printed in February 1904. The map of the Rájputána Agency, on the 16-mile scale, was also completed and printed in the same month. Work was continued on the two maps of Bengal, Bihar, Orissa and Chota Nagpur, on the 32-mile and 16-mile scales, respectively, on which heavy additions have to be made to the stones. 59 district maps, prepared from copper-plate transfers from Atlas sheets, were dealt with during the year, of which 26 were in hand at the close of the previous year. 19 of these were printed; proofs of 27 more were sent to the "drawing office," and 13 are still in progress.

The work done by lithography for other departments was as usual of great variety, and quite half the staff of litho draftsmen was engaged upon it throughout the year. The following are the more important items:—

The remaining three sheets of the new Telegraph map of India on the 32 inches=1 mile scale, were completed and proofs despatched early in the year.

All six sheets have since been returned with corrections, and these have been carried out and a second proof of the map supplied. Four large maps were prepared from copper-plate transfers for the Inspector General, Army Remount Department—one in nine sheets, one in four, one in two and one in a single sheet. These were all completed and proofs supplied, which have been returned with many corrections involving the entire re-doing of at least one of the maps. For the Linguistic Survey, 14 language maps were prepared, all of them in several colours, and five of them were printed. An irrigation map of the Punjab, in four sheets and five colours, was in hand during the year and was nearly completed at its close. Heavy corrections were made to another Irrigation map of the United Provinces. For the General Officer Commanding the Forces, Bombay, five large maps of Karachi, Hyderabad and Jacobabad cantonments, Ghizni sanitarium and Karachi rest-camp were prepared and printed. For the Traffic Superintendent, North Western Railway, a map of that railway and connected lines in black and two colours, was prepared and 10,000 copies were printed. For the United Provinces Government, a map showing canals completed and proposed was prepared and proved, and is now having additions made to it. For the Foreign Department, 25 maps and diagrams were lithographed and copies in various numbers were supplied of all except one, which is still in hand. For the Government of India, Public Works Department, 38 plans and diagrams were lithographed, of which 25 have been completed and printed, the remainder still awaiting press order.

Just before the close of the year a new lithographic printing machine, by Messrs. Furnival & Co., was received on indent from England. It was erected early in September 1904, but was not in working order when the year closed, owing to unavoidable delay in attaching the electric motor by which it will be driven. It is slightly larger than our present largest machine, and will be a valuable addition to our printing power. It is intended to utilise it exclusively on departmental work, principally standard sheets. With this new machine, and the improved methods referred to in para 49 about to be introduced in the "negative section," it is expected that the outturn of departmental work will show a considerable increase next year. The new electric motors, with one or two exceptions, gave no trouble. The motor attached to one of the type-printing machines broke down several times and caused much delay while it was being repaired, but it is now in good order. The change from steam to electric power has proved to be an unqualified success. There was not a single break of any importance in the continuity of the current during the year, and the motors, with the single exception already mentioned, have amply fulfilled all our expectations.

52. *Map Record and Issue Office.*—The work in this office shows a very considerable increase on the returns for last year, except in the number of sheets issued. The purely clerical work, *i. e.*, number of letters and invoices issued and received shows an average increase of over 25 per cent., and as the staff has not been increased, it has proved a matter of the greatest difficulty to keep pace with the demands.

Eighty-six thousand, four hundred and eighty-nine sheets of an aggregate value of ₹1,04,098 were issued during the year, and of this total a sum of ₹16,223 was realized from private sales. As reported last year no further despatches of printed cadastral maps were made and the falling off both in number and value of the issues as compared with the return for last year, may again be considered as due to this cause.

The number of new maps received for publication was 142, whilst 528 were published, of which 336 were reprints. The number of original maps, volumes of records, etc., issued from store to other departments amounted to 7,983, of which 4,403 were received back again.

The transferring of the original cadastral sheets from this office to the various head-quarters of Local Governments or districts, has been carried on steadily throughout the year. Those of districts in the United Provinces of Agra and Oudh, of 9 districts in Burma, of 18 in Bengal and of 3 in Assam, making a total of 55,265 sheets, were despatched from the office during the year, and it is hoped that this work will be completed by the end of next year.

The transfer of the large scale forest maps to the Office of the Superintendent, Forest Surveys, Dehra Dún, has been continued, and a total of 11,731

copies of 278 maps of the Burma forests has been despatched during the year. This work is in abeyance at present as the accommodation at Dehra is not yet completed.

The work of revising the catalogues and bringing them up to date has also been steadily proceeded with. The catalogues of the sheets of the Atlas of India, of the maps and plans of Bengal, and of "India and adjacent countries" have been published, whilst those of the Punjab and United Provinces are well advanced, and the remainder will be prepared as expeditiously as possible.

With the work of revising the catalogues, advantage is also being taken of examining and re-arranging the printed sheets, but with a total of nearly four million such maps to deal with, comparatively little progress has been made with this most desirable work owing to the insufficiency of the staff. It is a work quite apart from the usual routine, and the establishment is not strong enough to allow of a few men being told off specially to carry it on continuously, as all hands are fully occupied in complying with current demands and in carrying on the clerical work.

Only 1,422 special maps were opened out and re-stored flat during the year. This number would have been largely exceeded, but for the fact that space for storing them depends on the rate of transfer of the forest maps to Dehra Dún, and as pointed out above, the rack accommodation for the latter at Dehra is not yet complete.

The improvement in the state of this office mentioned in paragraph 67 of last year's report, is steadily maintained and the credit is mainly due to the Head Clerk Mr. Rundlett and the Map Curator Mr. McCurley. The staff of the office have with one or two exceptions ably assisted the above officers.

53. *Mathematical Instrument Office.*—During the year under report, *i.e.* from 1st April 1903 to 31st March 1904, there has been a considerable increase in the demands made on this office. For each of the last three years the value of instruments, etc., issued was ₹2,72,976, ₹3,10,348 and ₹3,64,646, respectively, and the value of repairs to instruments returned for that purpose was ₹29,345, ₹32,242 and ₹37,449, respectively. The value of instruments returned "on deposit" during each of the last three years has remained fairly constant.

The book value of the stock in the "serviceable store in hand" at the end of each of the last three years was ₹5,13,547, ₹4,72,065 and ₹3,85,145, respectively. This result is satisfactory and is due to a considerable extent to the fact that, during the last two years, indents for instruments, etc., obtained from the Director General of Stores may be submitted piecemeal, while formerly only one large annual indent was permissible. It is of course dangerous to reduce this value too much, as some of the most valuable instruments take a considerable time to manufacture, and it is necessary to be prepared to meet the demands of Government officers within a reasonable time, even when the indents are unexpected and large.

The book value of the stock in the "repairable store in hand" at the end of each of the three last years was ₹2,30,155, ₹1,80,999 and ₹1,64,474, respectively. This result is also satisfactory, the principal cause of the reduction in value being on account of instruments which had been lying for a considerable number of years in this store, which have now been transferred to the "serviceable store," through the workshop. Further reductions by this means will be very small in future as the accumulation of instruments that could be profitably converted or repaired, is practically absorbed. The present stock consists mainly of more or less obsolete instruments, some of historic interest might with advantage be written off and placed in a museum, and others, although there is no regular demand for them at present, might possibly be required later on when they would be at once repaired and issued. As soon as it is evident that any of the instruments of this latter class are absolutely out of date and useless, they will be condemned.

The "profit and loss statement" for the workshop shows an increased profit. The number of men and boys employed at the end of each of the last three years was 205, 255 and 320, respectively. The piece work system has been further extended and has proved so beneficial that the increase in the value of the total outturn of work from the workshop has been considerable, the figure for each of the three last years being ₹1,12,865, ₹1,25,722 and ₹1,50,567, respectively.

The value of instruments, etc., manufactured in the workshop for the serviceable store during each of the last three years was ₹33,427, ₹47,729 and ₹57,095, respectively, while the value of those purchased locally was ₹17,793, ₹13,329 and ₹11,641, respectively. The continued increase in the former and decrease in the latter, are both very desirable results.

54. The value of instruments, materials, etc., obtained from the Director General of Stores during each of the last three years was ₹1,06,008, ₹1,01,594 and ₹1,46,509, respectively. These amounts should naturally show a considerable increase owing to the large rise in the value of issues, but have been kept down by the reductions that have been made in the value of the stocks in both the serviceable and repairable stores. These reductions cannot possibly be expected to continue and, in spite of the fact that there are increases in the value of the instruments manufactured by the workshop for the "serviceable store," a very considerable increase in the value of the indents sent to England must be expected in future years.

A new two storied building was completed and occupied during the year and has proved extremely useful, the upper floor is principally used for polishing and lacquering and the lower floor for testing aud examining instruments.

BRANCH OFFICES, DEHRA.

55. *Trigonometrical Surveys.*—The superintendence of the Trigonometrical Branch was in the hands of Mr. J. Eccles, M.A., up to the 3rd November 1903, on which date he was relieved by Major S. G. Burrard, F.R.S., R.E. During the absence of Major Burrard on furlough Mr. C. H. McA'Fee held charge of the technical offices.

The following papers were printed during the year and are ready for issue:—

1. A reprint of Professional Paper No. 5 on the attraction of the Himalayas on the plumb line in India.
2. Notes on the use of the Jäderin base line apparatus.

In addition to the above a 4th edition of the Auxiliary Tables was compiled and is now going through the press. A second edition of the Great Arc Meridional series, section 18° to 24°, and a revised rainfall pamphlet are also in the press.

Captain C. G. Rawling's and Sub-Surveyor Ram Singh's triangulation in Western Tibet, and Surveyor Mohammad Zakaria's traverse of the Hardwár-Dehra Dún railway line, were computed. Considerable progress has been made in the reduction of Mr. Barckley's snow peak triangulation, and Colonel Tanner's triangulation has also been taken in hand. Messrs. Serrao's and Jarbo's triangulation in Burma was examined and adjusted.

Data were supplied to 43 officers, and the comparison of press proofs was carried on as usual.

Two officers Lieutenants R. H. Phillimore, R.E., and H. S. May, R.E., were put through a course of trigonometrical, topographical and astronomical work, and five sub-assistants of the Provincial service went through a course of topographical surveying, traversing and mapping.

In the drawing section a special map of the country surveyed by Captain C. G. Rawling and Sub-Surveyor Ram Singh was prepared and printed. The railway line from Hardwár to Dehra Dún was plotted on the 4-inch standard sheets.

Seven triangulation charts and four standard sheets on the 1-inch scale, of Dehra Dún and adjoining districts, have been put in hand and are well advanced. Four maps of India and adjacent countries on the scale of 1 to 1,000,000 were taken up, but owing to press of work these had to be put aside very often and have not advanced so much as they should have.

A map of the Province of Ssu-Chuan in China has been compiled for the Quarter Master General, Intelligence Branch, and is nearing completion.

A map of the country five miles round Chandigarh on the 2-inch scale was prepared for the General Officer Commanding, Sirhind district.

The plotting of forest boundaries of the Hoshangabad district was completed, and 207 plots on the scale of 16 inches to a mile were supplied to the Deputy Commissioner, Hoshangabad.

Seven diagrams were drawn for the Superintendent, Trigonometrical Surveys, to illustrate a special report by him.

During a portion of the year a number of promising lads were trained to draw level sheets and to use the pantograph and from these 14 have been chosen and employed.

In the colouring section 2,200 maps were coloured.

In the photozinco section 864 maps, diagrams, etc., were photographed, against 889 during 1902-03, and 57,464 pulls taken as against 43,358 in the same period.

The compilation of the professional volume, giving the results of the spirit levelling in India has made good progress.

During the year 25 lines of levels extended over a distance of 4,040 miles, connecting 3,597 bench marks, were compiled and tabulated.

The photo-helio section carried on its work as usual.

56. *Forest Surveys.*—The offices of the Forest Survey Branch were under the superintendence of the Superintendent, Forest Surveys, and were employed as usual on correspondence and accounts, computations, area statements, the mapping of field surveys, the compilation of special working plans and other maps, the distribution of published maps, and the up-keep of the map records of the Forest Department.

During the year, 328 maps have been sent to press, and 293 have been published at Dehra Dún and Calcutta. These numbers do not include 111 maps of No. 17 Party which were published previously in the Bombay Government Photozinco Office, at Poona.

Nine thousand, seven hundred and sixty printed maps were issued, of which 5,840 were coloured and 3,704 were mounted in book forms.

During the year a sum of ₹247 was realised by the sale of maps but the demand for forest survey maps by the general public is not a large one.

Considerable progress has been made in the arrangement and storing of printed maps in a systematic manner in the Forest Survey Office.

A series of maps consisting of a map of India on the scale of 1 inch=32 miles showing the distribution of forest lands under the Government of India, a map showing the progress of forest surveys and working plans on the scale of 1 inch=48 miles, and of stock maps showing the distribution of the most valuable timber trees and the rainfall, were compiled by Mr. A. Descubes for the St. Louis Exhibition.

A series of lists of Forest survey maps of divisions, in which forest surveys have been completed, is under preparation.

LOCAL DRAWING OFFICES.

57. These continued the compilation of topographical maps at the following localities :—

58. *North-West Frontier Drawing Office, Mussooree.*—This office has been employed on the preparation of the maps of the Northern and North-West Frontier series, and South-West Asia series, in addition to which the hill shading of 4 sheets of the Khojak 6-inch survey, were drawn under instructions from the Quarter Master General's Department, for surprinting in red.

The following sheets were sent to press and subject to slight corrections by the Quarter Master General's Department, will shortly be published.

Northern Trans-Frontier series—

Sheet No. 2 S.E., (2nd edition) scale 1 inch=4 miles.

North-West Trans-Frontier series—

Sheet No. 7 N. W., scale 1 inch=4 miles.
" " 14 S. W. (3rd edition) scale 1 inch=4 miles.
" " 15 S. W. (Western half) (2nd edition) scale 1 inch=4 miles.
" " 21 S. W. (3rd edition) scale 1 inch=4 miles.
" " 29 S. W. (4th edition) scale 1 inch=4 miles.

South-West Asia series—

Sheet No. 72 (3rd edition) scale 1 inch=8 miles.
" " 73 " " " "
" " 73 N. E. scale 1 inch=4 miles.
" " 73 S. E. " " "

59. *Bangalore Drawing Office.*—This office continued the compilation of the "degree sheet" maps of Burma.

60. Local drawing offices at the following centres carried on as usual the compilation of 1-inch standard maps from cadastral surveys, *i. e.* one at Naini Tal in the United Provinces, one in Bengal at Calcutta, and a third in Assam at Shillong. The work done by these offices is contained in Part II of this Report.

ESTABLISHMENT.

61. During the year under report, Colonel St. G. C. Gore., C.S.I., R.E., vacated his civil appointment of Surveyor General of India. The following is an extract from Revenue and Agricultural Department letter No. 963—38-5, dated 12th July 1904, acknowledging the General Report for 1902-03.

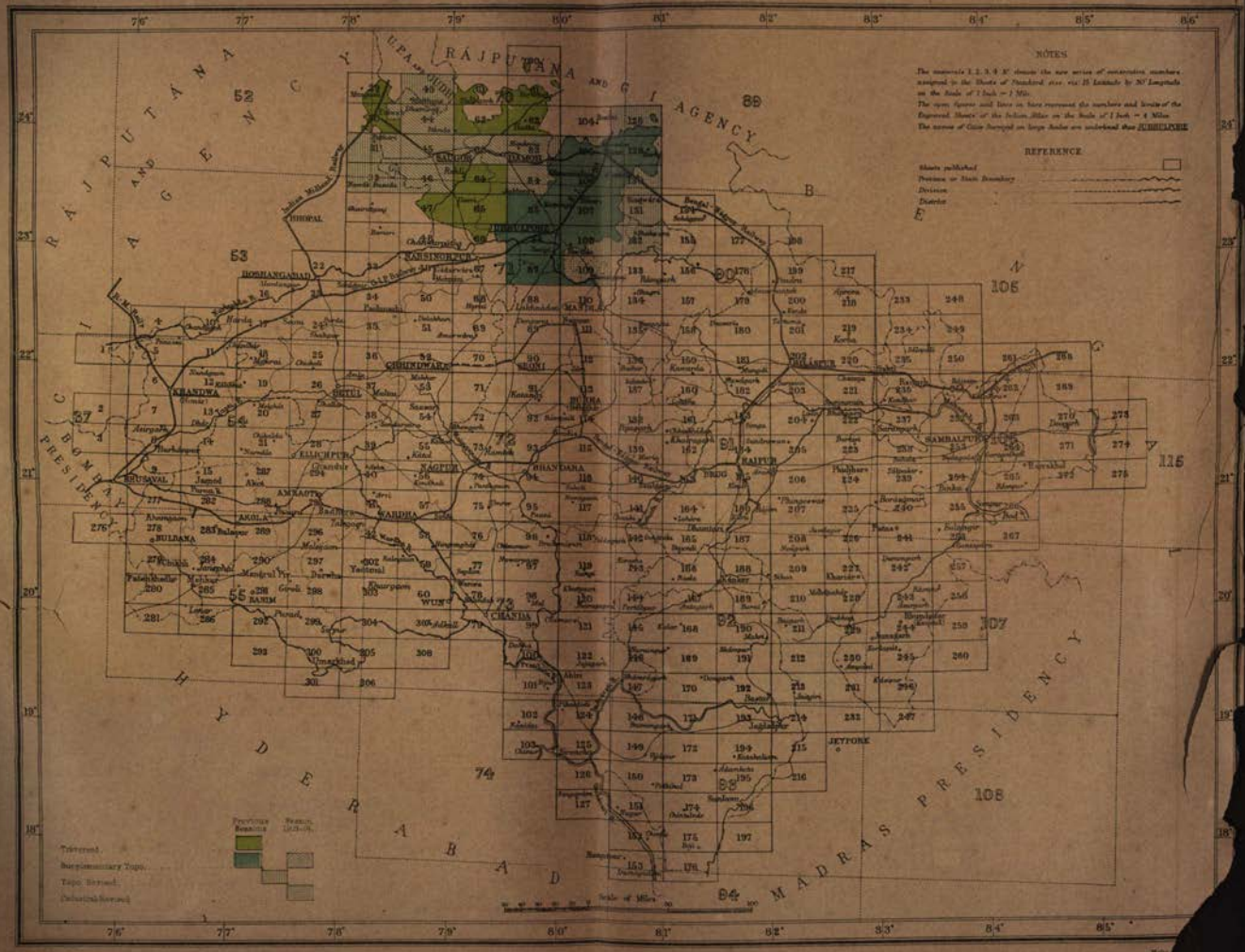
"This report is the last to be prepared under the direction of Colonel St. G. C. Gore, C.S.I., R.E., late Surveyor General of India, who retired in February last from the service of Government after having served for more than 30 years in the Survey of India. Colonel Gore was appointed Surveyor General on 1st October 1899, and thus occupied for over four years the responsible position of head of the department. The Government of India desire to take this opportunity of placing on record their high appreciation of the services rendered by Colonel Gore as Surveyor General and of his efficient and successful administration of the department; and their good wishes go with him in his retirement."

62. In the Provincial service the department has lost the services of twelve officers during the year, *viz.*, by the retirement of Messrs. R. C. D. Ewing, E. A. Wainright, J. Hickie, W. J. Cornelius, J. R. Scott, G. E. Parker, P. J. Doran, J. C. Swiney, G. G. Vander-Beek and Munshi Imam Sharif, K. B., and by the death of Messrs. H. A. Gibson and F O. Scott. Ten additional appointments were sanctioned during the year under Revenue and Agricultural Department No. 848, dated 23rd June 1904.

CENTRAL PROVINCES.

INDEX TO SURVEYS.

1903-04. No. 1 PART



PART II.

THE OPERATIONS OF FIELD PARTIES.

TOPOGRAPHICAL SURVEYS.

CENTRAL PROVINCES.

No. 1 Party.

Personnel.

Captain A. H. B. Hume, R.E., Officiating Deputy Superintendent, 1st grade, in charge from 23rd November 1903.
Mr. R. C. D. Ewing, Extra Deputy Superintendent, 2nd grade, in charge up to 22nd November 1903.
Mr. B. M. Berrill, Sub-Assistant Superintendent, 2nd grade.
Munshi Ikbaluddin K. S., " " 2nd "
Mr. F. C. Glass, " " 3rd "
20 Sub-surveyors, 8 computers, draftsmen, etc.

63. The Central Provinces detachment as it was then named, commenced field work at Saugor on the 16th October 1903. In March 1904, it was raised to the status of a party and designated No. 1 Party. The operations comprised—

(*a*) Traversing.
(*b*) Supplementary topographical survey and mapping on the scale of 2 inches to a mile.
(*c*) Revision survey.
(*d*) Preparation of district maps.

64. *Traversing.*—The traversing was carried on of forest excisions and scattered villages of 5 different districts, as called for by the local authorities. One sub-surveyor was employed throughout the season and a second for 2 months. They traversed 48 village circuits comprising 180 linear miles or 41 square miles. Copies of the data, and 16-inch plots were sent to the several Settlement officers.

65. *Supplementary topographical survey.*—Two camps were employed on this survey each including 8 trained and 3 probationary sub-surveyors, under Mr. Berrill and Munshi Ikbaluddin, respectively, and Mr. Glass was attached to Mr. Berrill's camp.

The area surveyed is :—

	Square miles.
District Saugor	1,841
" Damoh	998
State of Panna	2
Overlap Gwalior and Bhopal States	33
	2,874
Transferred to maps from reductions of forest surveys	526
	3,400

The work was tested by 1,079 *in situ* fixings and 280 miles of chaining, and 2,874 double value clinometric heights were observed, an average of one per square mile. A few heights were trigonometrically deduced, for areas where points with heights were deficient. The average daily outturn per man for working days was 0·84 square mile, and the monthly average 22 square miles.

The expenditure on supplementary topographical survey amounts to ₹31,047 giving a cost-rate of ₹ 10·8 per square mile, and the mapping of 3,400 square miles cost ₹ 9,857 giving a further cost-rate of ₹ 2·9 per square mile. The mapping of the above area, included in 9 standard sheets, is completed and ready to submit for publication. It was found this season that the details from the old 4-inch Revenue surveys that had been reduced and entered on the field sections, as mentioned in last year's report, were of no assistance but rather a hindrance, as in hilly ground the detail was quite inaccurate, and the face of the country has entirely changed as regards village sites, cart roads, foot-paths, tanks, etc. The reduced details of the main streams and boundaries from the 16-inch local agency maps were, however, found accurate and useful.

The field sections for next season's supplementary topographical survey of Saugor district have been prepared from reductions of the 16-inch maps and those of Narsinghpur district are being similarly prepared.

66. *Revision survey.*—In the outlying States, and portions of Mandla district falling in the standard sheets under survey, a few corrections and additions in map detail were reported by local authorities, to whom the maps under revision had been previously sent. These few details were inserted in the field, and in some sheets a considerable time was spent in getting these details to agree with those in the portion of the sheets taken up by the supplementary survey. In this way 6 standard sheets have been completed and are ready for publication. Seven others are in hand. This is a necessitous form of revision, and it can only be described as better than nothing, some of the surveys concerned being 40 years old.

67. *District maps.*—The district map of Jubbulpore is being prepared on 4 sheets on the $\frac{1}{8}$-inch scale for reduction to the $\frac{1}{4}$-inch, and a similar map will be prepared of each district as it is completed.

68. The programme for next field season is as follows:—

(1) Supplementary topographical survey of 3,000 square miles to complete Saugor and Damoh districts, and part of Narsinghpur.
(2) The traversing of 22 villages in Chánda district and any others that may be asked for by the local authorities.
(3) The revision survey of all such portions of Mandla district, Rájputána and Central India, as fall into the standard sheets of Damoh and Saugor to complete them up to graticule limits.
(4) Combined triangulation and traverse charts by standard sheets will also be commenced.

69. The party was inspected in the field by the Deputy Surveyor General on the 18th October 1903, and again in recess on the 28th July 1904, also by both the Surveyor General and Deputy Surveyor General on the 4th August 1904.

LOWER BURMA.

No. 3 Party.

70. The main body of the party left recess quarters at Bangalore on the 18th November 1903, the triangulators having been sent in advance to Thayetmyo and Toungoo between the 15th and 28th October. Field work closed on the 19th May, and the recess office re-opened at Bangalore on the 30th May 1904. The outturn was as follows:—

Personnel.

Mr. E. F. Litchfield, Deputy Superintendent, 1st grade, in charge from 24th October 1903.
Mr. P. J. Doran, Extra Assistant Superintendent, 1st grade, in charge up to 23rd October 1903.
Mr. W. M. Gorman, Extra Assistant Superintendent, 6th grade.
Mr. J. Donaghey, " " " 6th "
Mr. E. Claudius, Sub-Assistant Superintendent, 2nd grade.
Munshi Asmatulla Khan, " 2nd "
Mr. H. D. W. Stotesbury, " 3rd "
21 Sub-surveyors, etc., and 6 draftsmen.

	Square miles.
Triangulation	4,836
Detail survey on the 1-inch scale	2,148
Supplementary topographical survey on the 1-inch scale	455

71. The triangulation was carried out by Messrs. Gorman and Claudius, Munshi Asmatulla Khan and Sub-surveyors Abdul Hak and Ram Sarup. The area triangulated was very hilly and in the Yamèthin and Toungoo districts densely forest clad, with a sparse population. In the Shan States the hills were bare and much cultivated by the Karens who congregate in large villages and from whom ready assistance was received. The supplementary survey was confined to two small hilly tracts in Magwe and Minbu districts, which had been cadastrally surveyed. The detail survey was checked by Mr. Donaghey and Munshi Asmatulla Khan. The boundary between Thayetmyo and the districts Kyaukpyu and Sandoway falls into the area surveyed, but as it has not yet been accurately defined, it could not be inserted on the field sections.

INDEX TO THE SURVEY OPERATIONS IN BURMA NORTH OF LAT. 18°
REFERENCES.
Previously Surveyed on Scale 2" & 4" = 1 Mile
Do. do. 2" = 1 Mile.
Do. do. 4" = 1 Mile.
Do. Triangulated
Do. Revised Revenue Surveys.
Surveyed during Season 1905-06 on Scale 4" = 1 Mile
Do. do. do. 2" = 1 Mile
Do. do. do. 1" = 1 Mile
Triangulated...do.
Traversed...do.
Revenue Survey Revised.
Sheets Published.
Province Boundary.
District...do.
NOTES.
The numerals 197, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.
The names of Towns surveyed on large Scales are underlined thus.
MANDALAY.
Scale of Miles.
HILOKAN
KINDAT
Fort White
Falam
Haka
Khunglon
Kaladan
Lungaho
AKYAB
KYAUKPYU
Ramree
Cheduba
SANDOWAY
Sandoway
Kyaukpyu
Thayetmyo
PROME
Prome
Henzada
Bassein
Myaungmya
Maubin
Pantanaw
Thongwa
Rangoon
Pegu
Toungoo
Papun
Fort O'Donnell
Mawlaing
Mawlaik
Mawlaik
Mawlaik

BURMA SURVEY.

INDEX TO THE SURVEY OPERATIONS IN BURMA
SOUTH OF LAT. 18°

REFERENCES.

	2" = 1 Mile	4" = 1 Mile
Previously Surveyed on Scale 2" & 4" = 1 Mile		
....Do. ....do. ....1" = 1 Mile		
....Do. ....do. ....½" = 1 Mile		
....Do. ....Triangulated		
....Do. ....Revised Revenue Surveys		
Surveyed during Season 1903-04 on Scale 2" & 4" = 1 Mile		
....Do. ....do. ....do. ....1" = 1 Mile		
....Do. ....do. ....do. ....½" = 1 Mile		
Triangulated ....do.		
Traversed ....do.		
Revenue Survey Revised		
Sheets Published	358	
Province Boundary		
District ....do.		

NOTES.

The numerals 266, &c., indicate the Standard Sheets on the Scale of 1 Inch = 1 Mile.

The names of Towns surveyed on large Scales are underlined thus ..... RANGOON.

Scale of Miles.

40 20 0 40

Photo. S. I. O., Calcutta.

Reg. No. 799-S. 05.

72. The cost-rates per square mile are :—

	₹
Triangulation	10·8
Detail survey on the 1-inch scale	20·3
Supplementary survey on the 1-inch scale	16·0

The cost-rate of the supplementary survey is comparatively high on account of the hilly nature of the ground and the small area. Some intersected points were fixed by triangulation for the supplementary survey consisting of traverse stations of the cadastral survey and a few other points. The cost of this is not included in the above rates.

73. The season was a healthy one which may be attributed to the circumstances that the party took the field later than usual, and that the country worked in, overlaps the southern border of the dry zone.

74. The fair mapping which was in arrears has made good progress. Sheets 115, 117, 118, 119, 120, 163, 164, 259, 260, 261 and 262 have been published. Sheets 159, 165, 166, 254 and 255 are at press. Sheet 116 which was held back pending the completion of the 4-inch survey of the Mindôn Yoma forest reserve will be sent to press shortly. Sheets 211 to 214 on examination were found to require correction in respect to several boundary questions which have now been settled. The sheets are ready and will soon be sent for publication. Four sheets remain, *viz.*, 204 to 207; the drawing of these sheets was stopped for adjustment with the work of the forest surveys in the adjoining sheets 251, 252 and 253. They will be completed during the field season. Sheet 253 compiled in Calcutta, is at press. The fair mapping of the current season's work in sheets 75, 76, 113, 114, 157, and 158 is well advanced and will probably be submitted for publication soon after the party again takes the field. Sheets 203 and 258 are being compiled in the headquarters office from various surveys. The spelling of names, as usual, was examined by the Translator to the Government of Burma and traces of the fair maps were submitted to the local officials for examination. Eight triangulation charts are in hand and two will shortly be sent to press.

75. The programme for the ensuing season consists of the triangulation of sheets 302, 303, 304, 305, 306, and 307, and the detail survey of sheets 251, 252, 298, 299 and 300 including supplementary survey of such portions as have been surveyed cadastrally.

76. The party was inspected in the field by Colonel Hobday, Deputy Surveyor General, in March, and again at Bangalore in September 1904.

UPPER BURMA.

No. 10 Party.

Personnel.

Captain F. W. Pirrie, I. A. Deputy Superintendent, 2nd grade, in charge from 1st to 26th October 1903.
Lieutenant A. A. McHarg, R.E., Assistant Superintendent, 1st grade, in charge from 27th October 1903 to 16th June 1904.
Major J. M. Burn, R.E., Deputy Superintendent, 1st grade, in charge from 17th June to 24th July 1904.
Captain C. P. Gunter, R.E., Assistant Superintendent, 1st grade, in charge from 25th July 1904.
Mr. R. Waller-Senior, Extra Assistant Superintendent, 4th grade.
" P. J. Barrington, " " " 5th "
" F. P. Walsh, " " " 5th "
" W. G. Jarbo, Sub " " 1st "
" C. West, " " " 2nd "
" E. M. Kenny, " " " 3rd "
15 Sub-surveyors.

77. The party left recess quarters for the field towards the end of October 1903, and returned thereto between the 25th May and 9th June 1904. The operations were in continuation of those carried out in past years and consisted of topographical survey on the scale of 1-inch=1 mile including supplementary survey on the same scale of such portions as had been previously cadastrally surveyed. Owing to the flat nature of the country the triangulation of the area surveyed in detail this year had to be supplemented by traversing, to provide a sufficient number of points for the plane-tablers and special care taken to ensure accurate contouring. The traversing was carried out entirely by Provincial officers.

78. The outturn and cost-rates per square mile for the field season are as follows :—

Description of work.	Outturn.	Cost-rates.			
		R	a.	p.	
Triangulation . . .	1,725 square miles.	10	8	2	per square mile.
Suplementary survey, 1-inch scale.	2,704 „ „	26	0	9	
New detail survey, 1-inch scale.	301 „ „	27	4	10	
Traversing	335 linear miles.	10	10	11	per linear mile.

The secondary series of triangulation connecting the Manipur minor meridional series with the Mandalay series has been completed, and portions of sheets 69, 70, 106, 107, 108, 109 and 148 were triangulated. The detail survey comprises 1-inch standard sheets Nos. 146, 147, 192, 193, half of 194, 195 and a small area in 203. The nature of most of the ground surveyed rendered plane-tabling a matter of considerable difficulty. In Shwebo the country was flat and in parts heavily wooded and in Lower Chindwin the ground, though more undulating, was also covered with heavy jungle. In Sagaing again flat ground predominated. Consequently, the area surveyed in detail was not as large as expected, and the cost-rate of the detail survey shews a large increase on that of last year. The health of the party during the field season was good: Mr. Walsh fell ill and was obliged to proceed on medical leave.

79. The computations of the season's triangulation were completed as far as possible. The fair mapping of standard sheets 151, 198, 199, 203, and 250 left in arrears last year, was completed and will be sent for publication before field work is resumed, as also that of the whole of the current season's work in standard sheets 146, 147, 192, 193 and 195. The half of sheet 194 surveyed this year, has also been fair mapped. All the triangulation charts of the party have been brought up to date and three charts are complete and under despatch to Calcutta for publication.

80. The programme for the next field season is the triangulation of standard sheets 71, 72, 73, 74, 105, 106 and part of 107, the topographical survey on the scale of 1-inch=1 mile, partly new and partly supplementary, of standard sheets 148, 149, 150, half of 194, 196, 197 and the revision of the cadastral work in sheets 242, 243 and 244. The current five years' programme has been altered to enable this party to work more in unison with Nos. 7 and 20 Parties, and it is now as follows :—

Topographical survey on the 1-inch scale :—

1904—05 as above.	1906—07 sheets 143, 144, 145, 189, 190, 191.
1905—06 sheets 152, 109, 71, 72, 73, 74.	1907—08 „ 187, 188, 234, 235, 280, 281

81. The party was inspected by the Deputy Surveyor General in September at Bangalore.

UPPER BURMA.

No. 11 Party.

Personnel.

Mr. P. J. Doran, Extra Deputy Superintendent, 2nd grade, in charge from 26th October 1903 to 31st May 1904.

Captain C. P. Gunter, R.E., Assistant Superintendent, 1st grade, in charge from 1st June to 24th July 1904.

Major J. M. Burn, R.E., Deputy Superintendent, 1st grade, in charge from 25th July 1904.

Mr. W. M. Kelly, Extra Assistant Superintendent, 2nd grade.

Mr. J. H. Nichol, Extra Assistant Superintendent, 6th grade to 11th September 1904.

Babu Pramadaranjan Roy, Sub-Assistant Superintendent, 1st grade.

Mr. H. C. W. Stotesbury, Sub-Assistant Superintendent, 2nd grade.

Mr. V. W. Morton, Sub-Assistant Superintendent, 2nd grade.

Mr. A. B. Hunter, Sub-Assistant Superintendent, 3rd grade.

Mr. P. D. Simpson, Sub-Assistant Superintendent, 3rd grade.

Munshi Abdul Rahim, K. S., Sub-Assistant Superintendent, 3rd grade.

19 Sub-surveyors.

82. This party was placed under the Deputy Surveyor General from the 1st June 1904. The work during the season under report necessitated its division into two camps. The northern camp consisting of 7 sub-surveyors under Mr. Doran surveyed, on the 1-inch scale, the portions of sheets 506, 507, 508 lying to the east of the Salween river, while Mr. Kelly with 12 sub-surveyors conducted similar operations in sheets 513, 568, 569 and 609 up to the Burma Siam boundary and the whole of 567. Munshi Abdul Rahim, K.S., accompanied Lieutenant D. Forster, R. E., of the Burma Sappers and Miners in erecting pillars on the Burma China boundary.

SIND SURVEY.

1903-1904

Nos. 12 and 15 PARTIES

Photolithographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, September 1904.

No. D. S. S. L. 9-9-1904-850

REFERENCES.

Surveyed in previous Seasons Scale 1" = 1 Mile by No. 12 Party

Do. do. 8" = 1 Mile do.

Do. do. 4" = 1 Mile do.

Do. do. 2" = 1 Mile do.

Do. 1903-1904 2" = 1 Mile do.

Triangulated and Traversed in advance do.

Surveyed in previous Seasons Scale 1" = 1 Mile by No. 15 Party

Indus Riverain Survey

NOTES.

The numerals 63, etc., indicate the Standard sheets on the Scale 1 Inch = 1 Mile.

The figures and lines in stroken represent the numbers and limits of the Engraved sheets of the Indian Atlas.

Reg. No.238-S 04.

83. The party left Bangalore at the end of October and reached its destination about the middle of December, though the last man did not commence work till the first week of January. Field work closed about the middle of April and the party returned to recess quarters early in June. The country surveyed in detail embraced portions of the Shan States of Nonglün, Kēng Tung and Möng Pan and though mountainous and generally covered with heavy jungle, specially in sheets 567, 568, 569 and 609 was, with the exception of one or two localities, fairly well inhabited and furnished with foot-paths and mule tracks. The outturn for the season and cost-rates are:—

	Square miles.	Cost per square mile.
		₹
Triangulation	2,714	10·0
Detail survey on the 1-inch scale	3,153	25·3

84. The triangulation was carried out by Babu P. Roy and Messrs. H. C. W. Stotesbury and Morton in sheets 604, 605, 564, 565 and portions of 566 and 606. These officers also assisted in checking the detail survey. The outturn of triangulation is almost the same as that of last year, but the detail survey is about 700 square miles in excess. Work was much hampered by heavy mist in December and January, and dense haze in March and April, and a good deal of sickness was experienced. Thanks to the good offices of the Superintendent of the Shan States, Sir George Scott, much assistance was received from the Government of Siam, who deputed an official to facilitate arrangements for the work along the boundary.

85. During recess the fair drawing was completed of sheets 506, 507, 508, 513, 567, 568, 569 and 609 for publication in two colours and also of 10 triangulation charts which were submitted for publication. Four charts are still in hand. The computations of the triangulation were also completed.

86. This party will be employed during next season on the North-West Frontier under the administration of the Surveyor General.

87. The party was inspected by the Deputy Surveyor General in September 1904, at Bangalore.

SIND.

No. 12 Party.

88. The following programme was completed:—

(*a*) Network of secondary triangulation in two blocks, one running through the Karachi district in portions of sheets 35, 53, 54, 55, 73, 74 and 75, and the other through the Thar and Párkar district in portions of sheets 86, 87, 104, 105, 106, 107, 116, 117, 118, 119, 124 and 125.

(*b*) Village boundary traversing in portions of sheets 44, 45, 46, 65, 66, 67, 68, 87, 88, 89, 90 and 91.

(*c*) The detail survey on the 2-inch scale of portions of standard sheets 44, 45, 46, 52, 65, 72, 85 and 86.

(*d*) Lieutenant Rich during his absence from the party, triangulated an area of about 1,722 square miles in Berar (Central Provinces) in advance of detail survey which will be taken up by a new topographical party next field season.

Personnel.

Mr. C. F. Erskine, Officiating Superintendent, 2nd grade, in charge from 22nd August 1904.
Lieutenant E. T. Rich, R.E., Assistant Superintendent, 1st grade, in charge up to 12th December 1903, and again from 30th April to 21st August 1904.
Mr. G. G. Vander-Beek, Extra Assistant Superintendent, 1st grade, in charge from 13th December to 29th April, retired 16th September 1904.
Mr. R. F. Warwick, Extra Assistant Superintendent, 3rd grade.
Munshi Rahmatullah, Extra Assistant Superintendent, 6th grade.
Mr. E. C. J. Bond, Extra Assistant Superintendent, 6th grade.
Mr. H. A. Charrier, Sub-Assistant Superintendent, 1st " up to 6th December 1903.
Babu Dhani Ram, " " 1st "
Mr. R. E., Saubolle, " " 2nd "
38 Sub-surveyors, etc., and 3 writers.

89. The recess office at Karachi was closed on the 26th October 1903, and the party assembled at Nawabshah on the 1st November.

90. The traversing consisted as in former years, in following the village boundaries with offsets. There were 6 main circuits measured, 25 sub-circuits and 29 connecting lines. The angular work was checked by observations for azimuth at 99 stations on main and sub-circuits, the average angular error per station being ·53". The linear measurements amounted to 2,456 miles and were checked by 17 connections with the stations of the minor triangulation executed by this party, and with some stations of the Sehwán secondary series. The average correction per 1,000 links was 0·39 links. No permanent marks were laid down at traverse stations, but the marks erected by the revenue authorities to demarcate village boundaries have been utilized and the angles of the village boundaries fixed by offsets. The cost of traversing amounts to R9-15-9 per square mile.

91. The area surveyed in detail on 2-inch scale amounts to 2,715 square miles. The survey was carried out entirely by interpolation. It was tested from 1,212 *in situ* fixings, and was carried out under the direct supervision of the officer in charge. The cost is R10-3-3 per square mile.

92. Field work closed by the end of March 1904, and the party returned to Karachi for recess. The health of the party during the field season was only fair, there being many cases of pneumonia. From this complaint four *khalásis* died in the field, and the best surveyor in the party died of consumption soon after the close of the field season.

93. During recess the fair mapping of the entire area surveyed was completed. The mapping comprised 30 quarter sections. They were drawn on the 2-inch scale for reduction, and have all been despatched to the Trigonometrical office, Dehra Dún, for publication. Two maps of ½-inch work have been completed and sent for reproduction and publication, and the one remaining will be sent on completion of the drawing. The Sukkur district map is being drawn on the ½-inch scale for publication on the ¼-inch scale.

The triangulation and traverse charts of sheets 34, 35, 44, 45, 46, 53, 54, 55, 65, 72, 73, 74, 75, and 104 have been drawn and despatched to Dehra with list of co-ordinates. Those of sheets 86, 105, 106 and 107 are in hand.

94. Next season triangulation in advance will be taken up in sheets 91, 92, 93, 94, 108, 109, 110, 111, 120, 121, 122, 123, 126, 127, 128, 129, 130, 131, 132, and 133. Detail survey on 2-inch scale will be carried on in sheets 34, 35, 53, 54, 72, 73, 74, 92, 93 and 94, and that on 1-inch scale in sheets 36, 55, 56, 75 and 76.

95. The party was inspected by the Superintendent, Trigonometrical Surveys, in April 1904.

UNITED PROVINCES OF AGRA AND OUDH.

No. 14 Party.

96. The survey operations during the season included:—

Personnel.

Captain C. W. H. Symonds, I. A., Deputy Superintendent, 1st grade, in charge up to 21st October 1903.
Captain H. L. Crosthwait, R.E., „ „ 2nd „ in charge from 22nd October 1903.
Mr. W. H. Penrose, Extra Assistant Superintendent, 3rd grade, from 6th November 1903 to 16th January 1904.
Mr. C. George, Extra Assistant Superintendent, 4th grade, from 11th January 1904.
Mr. J. H. S. Wilson, „ „ 6th „ from 31st October 1903.
Mr. E. J. Biggie, „ „ 6th „
Mr. J. R. Newland, Sub-Assistant Superintendent, 2nd grade, up to 5th November 1903.
Mr. H. B. Simons, „ „ 2nd „
73 Surveyors, etc., and 2 writers.

(*a*) *Traversing* of remaining portion of Fatehpur, and the whole of Cawnpore districts.

(*b*) *Topographical survey* on a scale of 2 inches=1 mile in Allahabad and Fatehpur districts.

(*c*) *Supplementary topographical survey* in Partabgarh district to complete sheets to graticule limits.

(*d*) *Revision survey* for the same purpose in standard sheets bordering on the east and south of Allahabad district.

97. The field office opened at Cawnpore on 15th October 1903; work closed on 25th April 1904; the recess office opened at Mussooree on 5th May

UNITED PROVINCES.

1903-04. INDEX TO THE SURVEY OPERATIONS No. 14 PART.

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1904. Mr. C. George was in charge of the traverse camp and field drawing office; Messrs. Wilson, Biggie, and Simons were employed in charge of field camps, and of drawing sections during the recess.

98. The following tabular statement is a summary of work completed during the field season, and the cost-rates of the same :—

District.	Demarcation.		Traversing.		Triangulation.		Topography 2"=1 mile.	
	Square miles.	Cost per square mile.	Square miles.	Cost per square mile.	Square miles.	Cost per square mile.	Square miles.	Cost per square mile.
		₹ a. p.		₹ a. p.		₹ a. p.		₹ a. p.
Allahabad.	...	...	...	...	650	2 10 1		
Fatehpur .	2911	1 14 8	2911	15 7 9	...	...	*2221	9 14 1
Cawnpore.								

* Includes 285 square miles of supplementary survey in districts Partabgarh and Rai Bareli.

99. The origins used for the survey were as follows :—

Allahabad . .	longitude 81° 45′	latitude 25° 15′
Fatehpur . .	„ 80° 45′	„ 25° 45′
Cawnpore . .	„ 80° 15′	„ 26° 15′

100. The area topographically surveyed on the scale of 2 inches=1 mile, is contained in the following standard sheets of the United Provinces :—Nos. 124, 125, 139, 140, 141, 154, 155, 156, 157, 167, 168, 169 and 170. The mapping of almost all this work has been completed.

101. The country traversed and topographically surveyed was similar to that of last season and no special difficulty was encountered.

102. The programme for the coming field season is as follows :—

(*a*) *Topographical survey* on a scale of 2 inches=1 mile in Allahabad, Fatehpur and Cawnpore districts of 2,173 square miles.

(*b*) *Supplementary topographical survey* to complete sheets to graticule limits amounting to 327 square miles.

103. On the completion of the topographical survey of these districts this party will in future be placed at the disposal of the military authorities for work which is required for military purposes.

104. The party was inspected by the Deputy Surveyor General in October 1903, and by the Surveyor General in August 1904.

NORTH-WEST FRONTIER.

No. 15 Party.

Personnel.

Mr. E. A. Wainright, Extra Deputy Superintendent, 2nd grade, in charge up to 17th December 1903.
Captain F. W. Pirrie, I.A., Deputy Superintendent, 2nd grade, in charge from 18th December 1903.
Lieutenant R. H. Phillimore, R.E., Assistant Superintendent, 2nd grade, from 15th August 1904.
Mr. J. McHatton, Extra Deputy Superintendent, 2nd grade.
Mr. G. A. Knight, Extra Assistant Superintendent, 2nd grade.
Munshi Imam Sharif, K.B., „ „ 5th grade.
Mr. H. C. H. Cooper, „ „ 6th grade.
Subadar Kanak Singh, Sub-Assistant Superintendent, 2nd grade.
Mr. E. B. West, „ „ 2nd grade.
„ E. C. O'Sullivan, „ „ 3rd „
40 Surveyors, sub-surveyors, etc.

105. The programme consisted of triangulation and detail survey in Baluchistan, the survey of the cantonments of Ferozepore, Amritsar, Jhelum, and Jullunder and their bazars, and traversing in Baluchistan for settlement surveys.

The total outturn and cost-rates are given below :—

	Areas.		Cost-rates.			
			£			
Triangulation	1,460	square miles	7	13	9	
Detail survey	1,287	„	53	6	0	
Cantonment survey	59	„	250	4	4	
Traversing for cantonment surveys	59	linear miles	59	8	0	per linr. mile
Baluchistan settlement traversing	1,624	„	7	13	8	„

106. The field season lasted from October 1903 to June 1904, and the party again left for the field early in September 1904.

The cantonment detachment worked under the immediate supervision of Mr. J. McHatton and the settlement traversing in Baluchistan was carried out by Khan Bahadur Imam Sharif.

107. There was a certain amount of fever in September, October and November 1903, and three cases of pneumonia, but although the field season was very long the health of the party was good. Sub-surveyor Abdul Jalil, who left the party on 16th October 1903, was killed when on duty with the Aden detachment. By his death the party loses a conscientious frontier surveyor who has done much useful work.

108. In February 1904, a statement was made out shewing the time it would take to complete the triangulation volumes and charts of Baluchistan, and as it was necessary to have an officer with experience and knowledge to supervise the work done by the party in Baluchistan, Mr. E. A. Wainright, who had retired from the service on 18th December 1903, was re-employed and appointed to superintend the work from 18th July 1904.

109. The programme for the field season 1904-05, consists of triangulation and detail survey in Baluchistan, the North-West Frontier Province and tribal area, and the survey of cantonments and their bazars, of Siálkot, Ráwalpindi, Dera Ismail Khan, Nowshera, Murree and Cherat. No. 11 Party will be transferred from the Shan States in Burma as a temporary measure to assist the party in special surveys on the North-West Frontier.

110. An attempt will be made to prepare the field sheets of cantonments and bazars for reproduction by photozincography so as to avoid the labour and time taken in fair drawing them.

111. Mr. J. McHatton, who would have retired on pension on attaining the age of 55 years on 17th July 1904, was granted an extension of service for one year for employment on cantonment surveys.

112. The party was inspected by the Surveyor General, and Deputy Surveyor General during the recess.

PUNJAB.

No. 18 PARTY.

113. The party was transferred from the administrative control of the Deputy Surveyor General, to that of the Surveyor General, on the 1st June 1904.

Personnel.

Captain E. A. Tandy, R.E., Officiating Deputy Superintendent, 2nd grade, in charge.
Mr. W. Robert, Extra Deputy Superintendent, 2nd grade.
„ G. C. Swiney, Extra Assistant Superintendent, 2nd grade, retired 27th June 1904.
Mr. G. J. S. Rae, „ „ „ 5th „ from 25th June 1904.
Mr. J. O. Greiff, „ „ „ 6th „
„ C. E. C. French, „ „ „ 6th „
„ J. R. Newland, Sub-Assistant Superintendent, 1st „
Babu Maya Das Puri, „ „ 2nd „
Mr. C. E. Tapsell, retired Provincial Officer, from 8th September 1904.
80 Surveyors, draftsmen, etc.

114. The work was again of an extremely diverse nature, and will be described under seven separate heads.

The chief points of note during the year are, first, that the riverain surveys were even more extensive and scattered than previously, and have accordingly been a very serious distraction to the conduct of the ordinary topographical work; and secondly, that the drawing section has been steadily strengthened, by the enlistment and training of fresh draftsmen, and by the appointment of a retired provincial officer to supervise it; so that a satisfactory commencement has been made in the disposal of the heavy arrears of fair map-

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1903-04.

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ping due to the extensive large scale surveys which the party has taken up of late years.

115. The field season commenced early in November and closed about the middle of May, though a few detachments were sent in October to work on the Sutlej south of Multán district. It was a most unhealthy autumn, and nearly all the men who were sent down early suffered so severely from fever, for a month or two, that little or nothing was gained by their having commenced before the others. One amongst these men died in November; late in the season two *khalásis* died of plague, in Jullundur and Amritsar, and one surveyor showed severe symptoms of it but recovered. Otherwise, except for a good deal of suffering from boils as the weather became hot, the health of the party was good.

116. *Supplementry topographical survey on the 2-inch scale.*—This work consisted, as in previous years, of testing by plane-table, a compilation of settlement *masavis* fitted together by means of points previously determined by traverse work. The area completed was 2,669 square miles in Multán district, and 421 square miles in Amritsar; besides which the old 6-inch map of Amritsar and environs, dated 1869, was brought up to date, and an area of 82 square miles was surveyed in Bahâwalpur State to complete a standard sheet to graticule limits. The *masavis* of Multán district are very recent and for the most part sufficiently accurate for the 2-inch scale; the work was accordingly pushed on with a degree of rapidity which was only attainable by placing considerable reliance on the results of compilation. It has been decided that the accuracy so obtained is too conjectural, and that in future sufficient time is to be spent on every portion of the work to afford independent evidence as to the real accuracy of the settlement surveys. There has also been a tendency in this work to survey too rapidly and roughly, features lying in waste and desert tracts, and, though the latest maps show some improvement in this respect, henceforward the survey of all portions of the ground will be equally thorough and complete.

117. *Revision survey.*—To avoid the publication of new standard sheets in a fragmentary form, revision surveys were undertaken in those portions of three sheets which fall in Ferozepore district. The existing maps were about 17 years old; information was first obtained from all local officials as to any corrections which might be required, and surveyors were then sent to revise on the ground the details thus indicated. This procedure proved economical, and is satisfactory as far as it goes; though the assistance of local officials in such matters is liable to be somewhat perfunctory, and there is, therefore, no guarantee that the whole area has been thoroughly brought up to date in every possible respect.

118. *Traversing.*—This was continued in Multán and Muzaffargarh districts, with a view to affording fixed points on which the 2-inch compilation and supplementary surveys are based. The conditions were generally favourable for the utilization of the old traverse records of 1854, and the procedure for doing this was much developed, with the result that an outturn of 3,441 square miles was effected at a greatly reduced cost.

119. *Riverain surveys.*—The general object of this work has been described in previous reports. During the past year a good deal has been done, in conjunction with the Punjab Government, to develop various details of procedure so as to increase the value of the results, and make them more suitable for the future use of the Settlement Department. Various riverain traverses were run over extensive reaches of the rivers Sutlej, Beas, Jhelum, Panjnád, and Indus; in districts Multán, Muzaffargarh, Dera Gházi Khan, Dera Ismail Khan, Miánwáli, Jullundur, Ludhiána, Amritsar, Gurdáspur, Hoshiárpur, Gujrát, and Jhelum; and in Bahâwalpur, Kapurthala and Kashmir States; comprising a total area of 1,284 square miles of new traverse and a great deal of very troublesome supplementary traversing in old areas. Riverain plane-tabling, on the Indus, Panjnád, and Sutlej rivers, embraced an area 1,705 square miles; but it is proposed to discontinue this work in future, as it is impossible to carry it on in such scattered localities without very serious detriment to the ordinary work of the party.

120. *Reduction and compilation of masavis.*—Over 9,000 *masavis* of Multán and Muzaffargarh were reduced to the 2-inch scale, and their compilation as a basis for the new standard sheets is well advanced. Nearly

10,000 riverain *masavis* were reduced to the 4-inch scale, and the compilation of 207 riverain sheets was carried out; the whole of the riverain compilation will have to be amplified on account of the latest arrangements, under which all sensible discrepancies are to be clearly shown on the riverain maps.

121. *Simla surveys.*—The protracted work of mapping all the estate boundaries in Simla on a scale of 50 feet=1 inch was at last completed, by the survey of the new railway line and its boundaries and the revision of the 17 sheets in which it falls. Progress was constantly delayed on account of the difficulty of getting the railway officials to arrange for the complete demarcation of their boundaries. A good deal of scattered work was carried out, on the 6-inch scale, in Mashobra, Naldera and Mahásu, in connection with the suggested extensions of Simla; further extensive surveys of the same nature were called for afterwards, but the work had to be refused as it would have caused serious detriment to the normal work of the party.

122. *Mapping.*—The whole of the 112 fair sheets of the Simla boundaries survey, with index sheets, etc., were completed and sent to press by the end of the recess season.

The arrears of mapping in the Punjab plains were nearly cleared off, while fair progress was made with the current fair maps.

These results were only obtained by keeping in abeyance the fair drawing of riverain surveys which are not urgently required, and by holding over all the arrears of Himalayan work during the first half of the year; a commencement was made in the disposal of these latter by detailing a small section to take them up during the recess season; this section is to occupy itself solely with Himalayan arrears throughout the year, and will be gradually strengthened as more draftsmen become fit for hill drawing. A good deal of difficulty has been experienced in enlisting and training suitable draftsmen, and it will be some time before the drawing sections can produce rapid and satisfactory work and bring themselves properly abreast of requirements.

123. *Programme for next field season.*—This allows for the continuation of 2-inch surveys in the neighbourhood of Multán and Muzaffargarh, and the extension of the district traverse work to the north and north-east; also for riverain traverses in various localities of the Punjab, and a special 6-inch contoured survey for military purposes in the neighbourhood of Khushálgarh on the Indus.

124. The party was inspected by the Deputy Surveyor General in June, and by the Surveyor General on various occasions during the year under report.

FOREST SURVEYS.

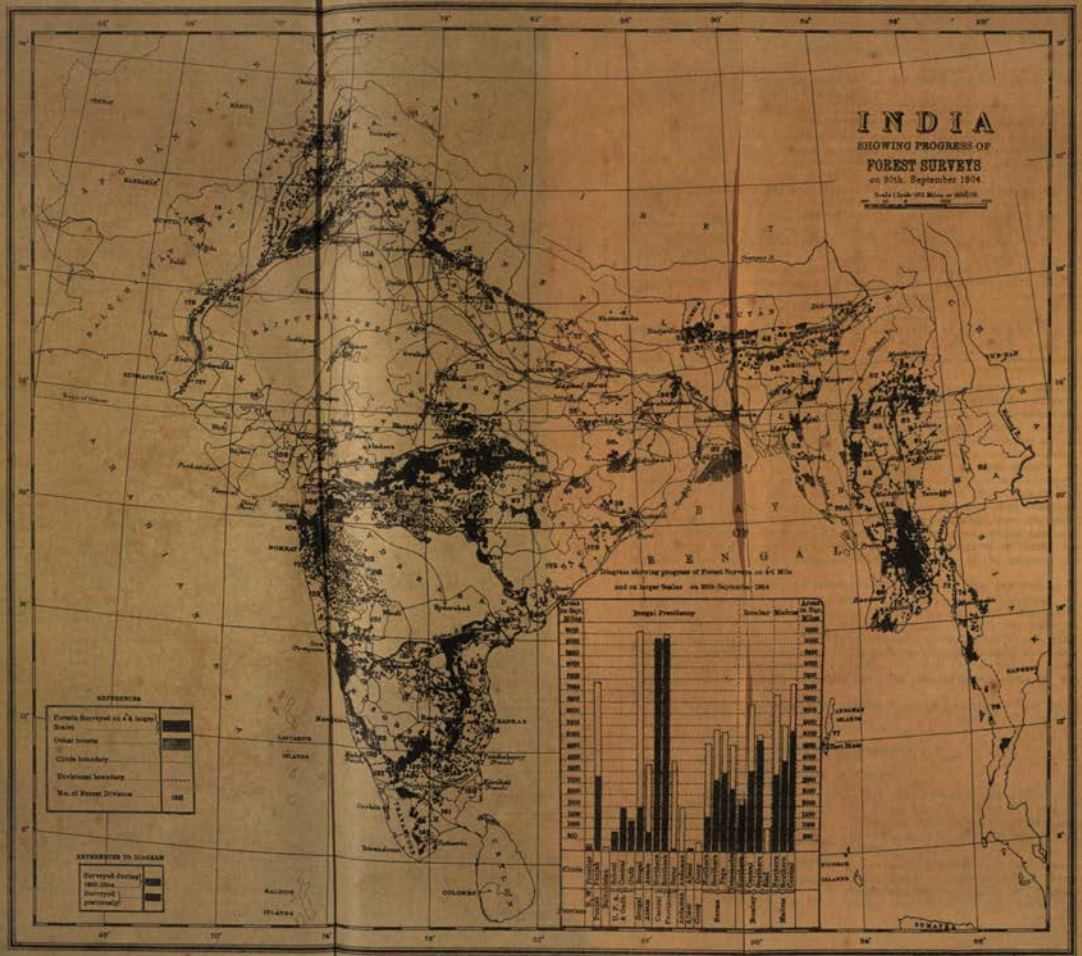
No. 9 Party (Forests).

125. This party was formed, after the unification of the Forest Survey Branch, out of the various Forest Survey detachments which had hitherto not been attached to any party. The Superintendent of Forest Surveys held executive charge in addition to his other duties.

Personnel.

The Superintendent of Forest Surveys in charge.
Mr. J. Marten, Extra Assistant Superintendent, 3rd grade.
„ A. Ewing, „ „ „ 4th „
„ C. Litchfield, „ „ „ 6th „
„ C. J. Veale, Sub „ „ 1st „
„ P. A. T. Kenny, „ „ „ 2nd „
2 Surveyors and 89 sub-surveyors.

126. The *locale* of operations, as formerly, lay in those districts in the Bengal Presidency where there was not sufficient forest survey work for a complete party; one detachment under Mr. J. Marten continued the survey of the forests in the Gáro hills, Kámrúp, and Nowgong districts in Assam, two detachments under Mr. A. Ewing and Mr. P. A. T. Kenny worked in the Mandalay, Katha and Shwebo districts in Upper Burma, another detachment under Mr. Veale completed forest surveys in the Darjeeling district, Bengal, while smaller sections under native surveyors worked in the Punjab, Bengal, and the United Provinces.



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127. The outturn and cost-rates for the year under report and the two previous years are given in the following table:—

Description of survey.	Outturn in square miles.			Cost-rates per square mile.		
	1901-1902.	1902-1903.	1903-1904.	1901-1902.	1902-1903.	1903-1904.
Detail survey 4 inches = 1 mile.				R	R	R
Bengal	427	232	310	48·2	64·0	64·0
Assam	...	134	160	...	97·8	85·2
Punjab and North-West Frontier.	112	300	209 (a)	23·1	35·3	25·0
United Provinces	...	100	36	...	29·7	27·1
Burma	274	303	447	85·9	63·5	90·7
Central Provinces	1,424	226	2·5	29·4	25·7	57·6
TOTAL	2,237	1,295	1,164·5			
Traversing	646 (b)	1,251 (b)	1,552 (b)	17·7 (c)	22·9 (c)	23·9 (c)
Triangulation	1,962	990	2,483	4·3	10·4	7·7

(a) Outline survey. (b) Linear miles. (c) Per linear mile.

The outturn of detail survey is less than for 1902-03, and only about half that of 1901-02: this is due to the easy surveys in the Central Provinces, where a large outturn at cheap rates formed the bulk of the work. The detachments are now chiefly employed in Burma, Assam, and Bengal, where, owing to expenses of transport and the natural difficulties of the country under survey, a much smaller outturn is to be expected. Except in Burma and the Central Provinces, the rates for detail survey are lower than for last season: the increase in the rates for the Central Provinces is due to the small area surveyed, and that for Burma, entirely to the more difficult nature of the country.

Formerly the detachments now forming No. 9 Party worked chiefly in districts where triangulation and traverse data were available; now the party has to undertake most of its own triangulation and traversing, which accounts for the large increase in these operations. The cost-rates of both are moderate and compare favourably, considering the nature of the country, with the rates of former years.

128. During the year good progress was made in drawing and publication of the maps, and it is hoped that by next year all arrears will be cleared off.

129. The programme for 1904-05 consists of 4-inch detail surveys in Burma, Bengal, Assam, and the North-West Frontier Province, and triangulation and traversing in the same Provinces excluding the North-West Frontier Province. Preliminary traversing and triangulation will also probably be undertaken in Berar, in preparation for a 4-inch survey of 730 square miles of forest reserves which is urgently required owing to the increasing value of the forests.

130. The party was inspected during the recess by the Surveyor General.

BOMBAY PRESIDENCY.

No. 17 Party.

Personnel.

Mr. B. G. Gilbert-Cooper, Officiating Superintendent, 2nd grade, in charge.
Mr. S. F. Norman, Extra Assistant Superintendent, 3rd grade.
Babu Amar Singh, Extra Assistant Superintendent, 6th grade, from 26th October 1903.
Mr. C. J. Veale, Sub-Assistant Superintendent, 1st grade, up to 28th October 1903.
Mr. P. R. Anderson, Sub-Assistant Superintendent, 1st grade.
2 Surveyors, 34 sub-surveyors, etc., and 1 writer.

131. The various camps of this party left Poona for the field at the end of November, and returned to recess quarters early in June, giving a full working season of six months.

The party was divided into three camps under Mr. S. F. Norman, Babu Amar Singh, and Mr. P. R. Anderson, respectively, and continued the survey on

various scales of forest areas in the Northern and Central circles of the Bombay Presidency; these operations comprised:—

1 *Northern circle.*—Detail survey on the 8-inch scale of the teak reserves of the Sháhápur *taluka* of the Thána district.

2 *Central circle.*—Supplementary triangulation and detail survey on the 4-inch scale in the Sátára district. Detail survey on the 8-inch scale in the Peint *taluka* of the Násik district, together with the completion of a small area (10 square miles) of detail survey on the 8-inch scale in the Málegaon *taluka* of the same district. The 8-inch surveys were confined to the more valuable "teak" reserves. Supplementary triangulation, and detail survey on the 4-inch scale in the Khándesh district.

In addition to the above, the special survey on the scale of 16 inches=1 mile of Mátherán hill station was undertaken and completed.

132. There was a good deal of sickness, and the services of 3 sub-surveyors were lost to the party for almost the entire field season from this cause.

133. The following table shows in detail the outturn, with cost-rates, for the year under report, and the two previous years:—

Description of survey.	Outturn in square miles.			Cost-rates per square mile.		
	1901-1902.	1902-1903.	1903-1904.	1901-1902.	1902-1903.	1903-1904.
				R	R	R
Triangulation . . .	320	1,373	677	19·6	1·11	15·3
Topography, 4-inch scale .	607	487	576	63·8	61·0	67·5
Topography, 8-inch scale .	162	240	158	136·1	130·0	138·8

The cost-rate for triangulation is higher this year than last, but does not exceed the mean of the two previous years; the slight increase to the rates is due to the smaller area, and to the country being more thickly wooded. That for 4-inch detail survey is rather higher than for the two previous years, which is owing to the scattered nature of the forest areas in the Sátára district, and to some loss of time in picking up "Proposed forest" boundaries, especially in *mami* villages, where no Revenue Survey maps were available as a guide to the surveyors. The cost-rate of the 8-inch detail survey is also rather higher than last year's for similar work, but very slightly in excess of that of the previous year. This is, in a measure, due to the loss in outturn owing to 2 of the best surveyors having been employed on the special survey of Mátherán hill station for the greater part of the season, and the loss of the services of 3 sub-surveyors from sickness for almost the entire field season.

134. During the recess good progress has been made with the mapping of the current season's work, and nearly all arrears of mapping of the former season's field work have been worked off, 117 maps were sent to press during the year under report, and it is expected that 100 more maps will be forwarded for publication by the end of November.

135. During the year, at the request of the Government of Bombay, a special survey on the scale of 16 inches=1 mile of Mátherán hill station was (together with the fair mapping appertaining thereto), completed. The whole plateau, covering an area of 3·33 square miles was most carefully surveyed, with contours having a vertical interval of 12½ feet. The cost of the survey, which amounted to R3,400-14-0, was borne by the Mátherán station fund.

136. The programme for 1904-05, is in continuation of that for the past season. The 8-inch detail surveys of Thána and Násik will be continued, and triangulation and 4-inch surveys will be continued in Sátára and Khándesh.

137. The party was inspected in September by Major C. W. H. Symonds, I. A., Officiating Superintendent, Forest Surveys, and early in October, by the Deputy Surveyor General on behalf of the Surveyor General.

MADRAS PRESIDENCY.

NO. 19 PARTY.

Personnel.

Captain C. L. Robertson, C.M.G., R.E., Deputy Superintendent, 1st grade, in charge.
Mr. G. T. Hall, Extra Assistant Superintendent, 1st grade, in temporary charge from 16th April to 15th July 1904.
Mr. W. F. E. Adams, Extra Assistant Superintendent, 5th grade.
Mr. M. J. Sheehan, Extra Assistant Superintendent, 6th grade.
Mr. C. C. Byrne, Sub-Assistant Superintendent, 1st grade.
Mr. H. A. Gibson, " " 2nd grade, died 12th August 1904.
Mr. B. C. Newland, " " 3rd grade.
57 Surveyors and sub-surveyors and 2 writers.

138. As in previous years, the party was divided into camps, the constitution of each being as under:—

(1) Mr. G. T. Hall with one assistant and 18 sub-surveyors and apprentices, working in the Godávari district (Northern circle).

(2) Mr. W. F. E. Adams with 16 surveyors, sub-surveyors and apprentices, working in the South Canara district (Southern circle).

(3) Mr. C. C. Byrne with 16 surveyors, sub-surveyors and apprentices, working in the Kurnool district and, towards the end of the season, in the southern portion of that of Kistna (Northern circle).

(4) Surveyor Balaji Dhondiba with 4 sub-surveyors working on revision surveys in the North Coimbatore district (Southern circle).

In addition to the above, Mr. Sheehan was employed independently on triangulation in Godávari, and Mr. Gibson and one recorder on similar work in the Trichinopoly and Chingleput districts. Triangulation and theodolite traversing were also carried out by some of the native surveyors working under the camp officers.

139. The various camps of the party, with the exception of the Coimbatore camp, left recess quarters in Bangalore early in November 1903 and, after a full working season of six months, closed field work in May 1904. The Coimbatore camp was detained in recess quarters for the purpose of completing mapping and did not take the field till 9th December 1903, returning to Bangalore about the 7th June 1904.

140. An area of 1,000 square miles was triangulated in Godávari, and a further area of 220 square miles in the Trichinopoly and Chingleput districts. In South Canara 428 square miles of triangulation in continuation of the work of previous seasons were completed, and in Kistna, 289 square miles. Two hundred square miles of reconnaissance in advance of tringulation was carried out in the North Malabar district, towards the close of the season. Most of the triangulation in Godávari, and the whole of that in Trichinopoly and Chingleput, was executed by Mr. Sheehan and Mr. Gibson, respectively. Elsewhere native agency was employed with results that have proved generally satisfactory.

141. 247 linear miles of forest boundaries were traversed in Ganjam, Godávari, South Canara and North Coimbatore. The outturn in this respect is less than that of last year, but has been purposely reduced as leading to unnecessary expense. The area topographically surveyed on the scale of 4 inches to a mile amounts to 803 square miles, but includes some 96 square miles of resurvey of former seasons' work in North Coimbatore. Much of this area had to be surveyed by means of the chain owing to the density of the forest and undergrowth. This was especially the case in Godávari, and the flatter parts of South Canara and North Coimbatore. The work was rigorously tested throughout with satisfactory results.

142. The country in which the work was carried on during this year presented much the same difficulties as that surveyed in former years, except that in the Godávari district they were accentuated by the extreme deadliness of the climate. The health of the party generally was bad, and in Godávari district the percentage of days of sickness to days of work among the European assistants and native surveyors only, excluding menials, which in other districts varied from 3 per cent to 7·8 per cent, rose to 16 per cent. The abnormally heavy rain which fell over nearly the whole of Madras late into November 1903, may perhaps have had something to say to these heavy percentages. The labour difficulty,

too, in Godávari assumed an acute phase, as local labour was found almost improcurable and the imported labour would not stay to face the unhealthiness of the climate. The South Canara district, as usual, also proved unhealthy. Only one member of the party, Mr. H. A. Gibson, has died during the year, but there has been a heavy loss from invalidings, both in the permanent and temporary establishments, and a number of native sub-surveyors have resigned. The effects of sickness, chiefly malaria, contracted during the field season have been severely felt throughout the recess season, and have seriously interfered with the progress of mapping. Latterly, the recrudescence of bubonic plague in Bangalore has interfered with the work of the party, as the native members of the party living in the bazars have constantly to be subjected to segregation.

143. During the recess the computation of the whole of the arrears on triangulation and traversing was completed, as also that of all current traversing, and a great part of the current triangulation. Thirty-two sheets, including 19 sheets partially drawn last year have been mapped. Owing to incomplete verification of forest boundaries, 4 sheets of the Cuddapah district, 9 sheets of Kurnool, 1 sheet of South Canara and 4 sheets of North Coimbatore, have been withheld from publication, while 3 sheets of the Cuddapah district have been submitted for publication as provisional issues pending settlement of boundaries under dispute. The demarcation of the South Canara-Mysore boundary is still pending, but will be undertaken during the ensuing field season, and when complete, the boundary will be surveyed.

144. The following table shows the cost-rates of the different classes of survey, and the areas surveyed for the year under report and for the two preceding years. The decrease in area and increase in cost-rates during the former are due, partly to the excessive unhealthiness of certain districts as noted above, partly to the fact that in South Canara, owing to the want of definite information as to forest survey requirements on which to frame a consistent programme of work, the survey of small scattered areas has had to be carried out, and also to the fact that a considerable charge on account of the mapping of arrears in the Cuddapah district has had to be incurred. The final cost-rate of outturn during the current year, based on its cost-rate of topography and mapping, added to the cost-rates of triangulation and traversing from previous years for the areas involved, works out to R121-1-4 per square mile.

Description of survey.	Outturn.			Cost-rates per mile.		
	1901-02.	1902-03.	1903-04.	1901-02.	1902-03.	1903-04.
	Sq. miles	Sq. miles.	Sq. miles.	R	R	R
Triangulation . . .	1,680	2,030	1,937	5	5	9·2
Traversing	414*	538*	247*	14	13	19·5†
Topography, 4 inches=1 mile.	1,306	1,411(a)	803	59	58	102·2

(a) Includes revision survey.
* Linear miles.
† Per linear mile.

145. The programme for the ensuing season comprises the continuation of triangulation in Ganjam, Godávari and South Canara, and the commencement and completion of the same in North Malabar. A small amount of theodolite traversing will be carried out in Godávari, and if the demarcation of the South Canara-Mysore boundary be sufficiently advanced during the season, this will also be traversed with the theodolite. The 4-inch detail survey will comprise the completion of the survey of forests of South Canara and North Coimbatore, the commencement of those in Ganjam and the execution of some 300 square miles in Godávari and 10 square miles in the Kistna district.

146. The nomenclature of the party has been changed with effect from 1st September 1904, from Nos. 9 and 19 Parties (Madras Forests) to No. 19 Party (Madras Forests).

147. The season's work has been verified with the aid of the Government notifications by the District Forest Officers of Godávari, South Canara, Kurnool and Kistna, who visited the recess quarters for the purpose.

148. The party was inspected during September by Major Symonds, I. A., Officiating Superintendent, Forest Surveys, and by Colonel Hobday, Deputy Surveyor General, on behalf of the Surveyor General.

BURMA.

No. 20 Party.

149. The party left Dehra Dún on the 12th November 1903 and commenced field work in Burma on the 10th December.

Personnel.

Captain A. Mears, I. A., Officiating Deputy Superintendent, 2nd grade, in charge.
Mr. P. F. Prunty, Extra Assistant Superintendent, 3rd grade.
Mr. S. S. Mc'AFee Fielding, Sub-Assistant Superintendent, 2nd grade.
Mr. J. H. Williams, " 2nd grade.
Munshi Amjad Ali, " 3rd grade.
73 Surveyors, sub-surveyors, computers, and writers, etc.

The field season closed about the 18th May 1904 in Upper and nearly a week later in Lower Burma, giving a working season of 5½ months, the maximum that can be expected in the Burma forests.

150. The party was divided into four camps and two detachments under the charge of the following assistants and surveyors:—

(1) Mr. P. F. Prunty with 10 traverse sub-surveyors and 6 computers in the Lower Chindwin, Yaw, and Myittha forest divisions.
(2) Mr. S. Fielding with 10 sub-surveyors in the Upper Chindwin and Myittha divisions.
(3) Mr. J. H. Williams with 6 sub-surveyors in the Lower Chindwin division.
(4) Munshi Amjad Ali with 12 sub-surveyors in the Myittha and Yaw divisions.
(5) Surveyor Sharf Uddin with 7 sub-surveyors and 1 computer in the Theyetmyo division.
(6) Surveyor Maung Kyaw Nyein with 5 sub-surveyors in the Myittha division.

In addition to the above there were 8 probationers attached to the various camps for instruction and training.

151. Subsidiary triangulation in continuation of last season's work, based on the Manipur minor meridional and Mandalay minor longitudinal series, was carried out over an area of about 610 square miles by Mr. Prunty.

152. The country, as in previous seasons, was thickly wooded, and to allow of the topographical details being correctly surveyed, theodolite traverses had to be extensively used as formerly. Nine hundred and forty-eight linear miles of traverse were completed, representing an area of about 670 square miles, which is slightly under that of the estimated traverse programme. The theodolite was set up on an average 16 times per mile. The majority of the traverses were computed and proved in the field.

153. An area of 671 square miles, was surveyed topographically on the 4-inch scale in the reserves of the Upper and Lower Chindwin, Myittha and Theyetmyo forest divisions. The country presented much the same difficulties as reported in the previous season, and consequently the slow and laborious method of plane-table traversing had to be adhered to.

154. The total expenditure on survey operations for the year ending 30th September 1904 is ₹1,39,510, as compared with ₹1,48,468 for the previous year. The decrease is due principally to the absence of heavy arrears of mapping and publication charges, the transfer of two more or less highly paid assistants from the party, and a slight decrease in the subordinate establishment.

155. The following tabular statement shows the outturn and cost-rates for the year under report and the two previous seasons:—

Description of work.	Outturn in square miles.			Cost-rates per square mile.		
	1901-1902.	1902-1903.	1903-1904.	1901-1902.	1902-1903.	1903-1904.
				₹	₹	₹
Triangulation . . .	250	1,161	610	15·0	3·2	7·4
Traversing	1,646(*a*)	1,173(*a*)	948(*a*)	53·5(*b*)	44·7(*b*)	44·5(*b*)
Topography, 4 inches = 1 mile.	724	623	671	122·3	136·6	135·7

(*a*) Linear miles of traverse.
(*b*) Cost-rate per linear mile.

The triangulation cost-rate is higher than that of last year, the increase being due to the smaller area triangulated; it may be noted, however, that nearly twice the number of points have been fixed.

The general cost per square mile for 4-inch topographical survey remains almost the same as for last season. The failure to reduce this somewhat high rate must be mainly ascribed to the difficult nature of the country under survey. Thickly wooded, high, and precipitous hills, intersected by deep valleys in which the undergrowth and vegetation was of the densest, necessitated the exclusive use of plane-table traverses, so that the outturn of even the best surveyors was necessarily small. The move of one camp during the field season, and heavy and unusual rain early in April, also tended to raise the cost-rate. It can hardly be expected to reduce this cost while the party continues to work in similar country.

156. The health of the party was fairly good until the end of March, when heavy and continuous rain caused a great deal of sickness amongst the native establishment. One sub-surveyor was sent on medical leave, ten *khalásis* died of fever and dysentery and one was drowned.

Supplies were not easily obtainable, and large quantities of rice had to be bought and stored at various centres in the areas under survey. The rationing of these food depôts was by no means easy, owing to the small number of Government elephants available for the purpose.

157. The examination of the area surveyed topographically shows the quality of the work to be satisfactory, no plane-table sections requiring revision. The testing was in the proportion of one linear mile to 1·93 square miles of detail survey.

158. The triangulation and traverse computations have been completed during the recess months, and the mapping of the current season's work will be completed before the party takes the field. The number of sheets submitted for publication during the year under report is 41, which includes 5 sheets of the previous season's work and 8 sheets of arrears mapping. There are now no arrears of mapping in the party.

159. The programme for 1904-05 is as follows:—

(1) Triangulation and traversing in the forest reserves of the Lower Chindwin and Yaw divisions.
(2) Topographical survey on the 4-inch scale in the Myittha, Yaw, and Lower Chindwin divisions.
(3) Traversing in the Prome and 4-inch detail survey in the Thayetmyo division.

160. The Superintendent, Forest Surveys, inspected the party in the field during the month of January and in recess in August.

BENGAL.

INDEX TO TRAVERSE SURVEYS.

1903-04. No. 4 PART.

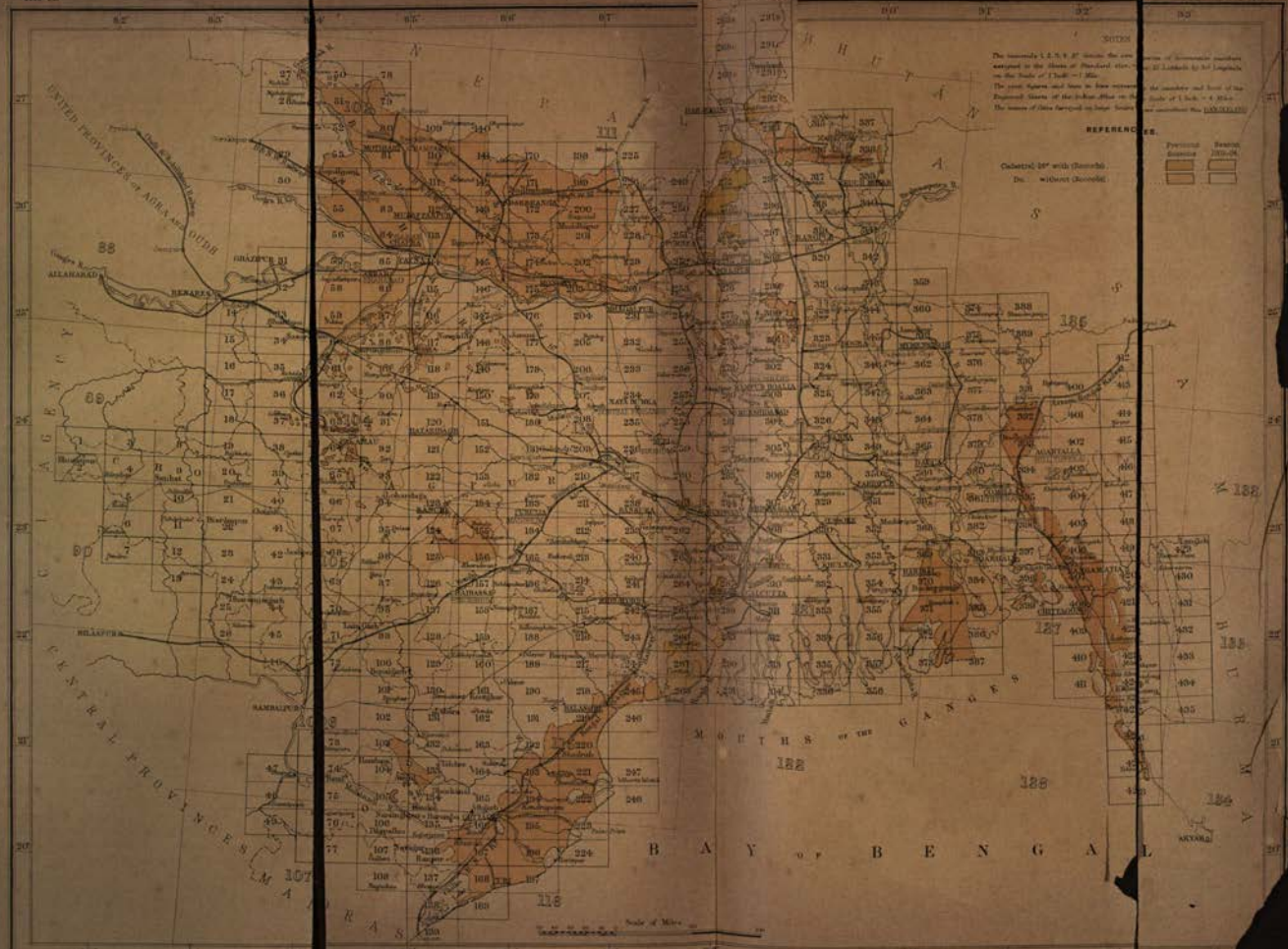
Published under the direction of Colonel C. Strahan, R.E., Surveyor General of India.

Reg. No. 710-S. 05.

BENGAL.

INDEX TO CADASTRAL SURVEYS.

1903-04. No. 4 PART.



Reg. No. 658-S. 05.

CADASTRAL AND TRAVERSE SURVEYS.

BENGAL.

No. 4 Party and 6 Detachments.

161. The operations in Bengal remained under the supervision of Major R. T. Crichton, I. A., Superintendent of Provincial Surveys, except for 5 weeks (from 1st October to 9th November 1903) when he was on leave and Captain F. C. Hirst, I. A., officiated for him. The outturn of the season is :—

	Square miles.
Traversing	5,028
Cadastral survey	4,054
Record-writing	4,065
Topographical survey on the scale of 4 inches=1 mile	463

This is the largest outturn in one season that has yet been accomplished. The programme was fully completed except in Ránchi and Midnapore districts, which was, however, more than counterbalanced by excess areas obtained elsewhere.

162. *Midnapore district.*—The operations consist of the cadastral survey with record-of-rights of the Jalamútha, Májnamútha, Balarámpur and other scattered estates which had been traversed during the previous season. The traversing consisted of the completion of some arrears and of the Jámirápál estate which was an addition to the original programme. The outturn was :—

Personnel.

Mr. C. S. Gasper, Extra Assistant Superintendent, 5th grade, in charge.
Mr. P. F. Delaney, Sub-Assistant Superintendent, 2nd grade.
2 Supervisors, 32 inspectors, 353 *amins* 13 computers, draftsmen, etc., 363 *moharrirs*.

	Square miles.
Traversing	22
Cadastral survey	621
Record-writing	486

As the records were not completed of the whole area surveyed it is impossible to give a cost-rate, but the scattered nature of the work points to a probable high one.

163. *Bhágalpur district.*—The outturn and cost-rates per square mile, are :—

	Area in square miles.	Cost-rates per square mile.
		₹
Traversing (*mauzawar*) for cadastral survey	168	35·8
Traversing for topographical survey	300	25·6
Cadastral survey	275	56·6
Record-writing	282	26·1
Topographical survey, 4 inches=1 mile	297	16·8

The area surveyed topographically includes 10 square miles of the Sonthal Parganas and consists of portion of the beds of the Ganges and Kosi rivers known as *diára* lands which it has been decided to survey in future on the 4-inch instead of the 16-inch scale. All topographical items such as rivers, roads, village sites (in blocks) and the larger patches of cultivation have been mapped. The village boundaries were not surveyed, but have been taken from the Revenue survey maps of 1846-48 and shown on the maps in red. The Government and temporarily settled estates situated in the *diára* lands were surveyed cadastrally, reduced by pentagraph and entered in the maps to make each sheet complete. There were 4,981

Personnel.

Traverse.

Captain F. C. Hirst, I.A., Assistant Superintendent, 1st grade, in charge to 29th February, 1904.
Lieut. L. C. Thuillier, I. A., offg. „ „ 1st „ in charge from 1st March 1904.
Mr. H. A. Hardless, Sub- „ „ 3rd „
1 Supervisor, 41 sub-surveyors, 33 computers, etc.

Cadastral.

Mr. A. W. Smart, Extra Assistant Superintendent, 1st grade.
„ C. S. Kraal, „ „ „ 3rd „
„ P. L. Causley, Sub- „ „ 1st „
„ O. J. H. Hart, „ „ „ 2nd „
„ O. E. C. Judd „ „ „ 2nd „
„ G. W. Archer, „ „ „ 3rd „
„ I. Newton (proby.) „ „ „ 3rd „
4 Supervisors, 68 inspectors, 600 *amins*, 45 draftsmen, 300 *moharrirs*.

theodolite stations in the area traversed, of which 415 have been marked by stones, 246 by cylinders and 4,320 by wooden pegs.

The cost-rates for the traversing are high because the cost of moving the establishment into the field all falls into the expenditure under this head, the traversing having occupied the earlier portion of the field season. Also the area traversed is a small one which always means high cost-rates. The total cost-rate, R82·7 for cadastral survey and record-writing, is very low and is attributable principally to the large size of the fields which average 1·3 acre, but also to the fact that the Bihár establishment is now highly trained.

164. *Purnea district.*—The operations in this district were of the same nature as those in Bhágalpur and were carried out simultaneously by the same establishments, the outturn and cost-rates being :—

	Area in square miles.	Cost-rates per square mile. R
Traversing for cadastral survey	1,997	26·6
Traversing for topographical survey	183	16·4
Cadastral survey	1,499	64·9
Record-writing	1,499	36·6
Topographical survey, 4 inches = 1 mile	166	13·5

The traversing was connected with 9 stations of the Great Trigonometrical survey, there were 38,812 traverse stations marked by 4,491 stones, 30,769 clay cylinders and 3,552 pegs, the latter having been used in the 183 miles of *diára* lands which were traversed for topographical survey.

The comparison of village boundaries with the Revenue survey maps of 1842-48, disclosed few changes of any importance except in the Kosi *diára* tract. There were 521 boundary disputes. All the maps and records were completed in every respect and the records and 3 printed copies of each of the maps were furnished to the Settlement Department.

The cost-rate of the *mauzawar* traversing is slightly higher than that of last season which is attributable to the smaller average size of the villages. The rate for traversing for topographical survey is fair considering this is the first season the establishment has been employed on this kind of work, but it is expected that in future it will not exceed R12 per square mile. The combined rate for cadastral survey and record-writing is very low and is due to large fields (1·1 acre), large and compact programme, and a fully experienced establishment. The outturn of cadastral survey given above does not include the overlap along the Srinagar-Baneli estate boundary, the necessity for which has been explained in former reports, nor does it include the resurvey of 905 scattered holdings of that estate, aggregating 2,480 acres, which were found to be out of position and configuration.

165. *Backergunge district.*—The operations consisted of the completion of the traversing of the district excluding the Sundarbans and of an area of about 60 square miles of cultivation in the north of Amtali *thána* lying within the Sundarbans, which will come under cadastral survey; the cadastral survey with records of 468 square miles in Gaurnadi and Mehdiganj *thánas*, and of 405 square miles in the island of Dakhin Shahbázpur, and the record-writing of 96 square miles of the Rabnabad islands which had been surveyed during the previous season. Two large rivers, the Tetulia and Ilsa, fall into the area surveyed and their banks were mapped, but their area, 150 square miles, is not included in the outturn which is given below together with cost per square mile.

Personnel.

Traverse.

Mr. C. H. G. Johnson, Extra Assistant Superintendent, 5th grade, in charge.
Mr. P. Kennegy, Sub-Assistant Superintendent, 2nd grade.
28 Surveyors, 17 computers, etc.

Cadastral.

Mr. N. Bedford, Extra Assistant Superintendent, 4th grade, in charge.
Mr. E. G. Hardinge, Sub-Assistant Superintendent, 1st grade.
Mr. F. W. Marten, Sub-Assistant Superintendent, 2nd grade.
Mr. A. B. Smart (Jr.), Sub-Assistant Superintendent, 2nd grade.
Mr. T. F. Kitchen (proby.) „ „ Superintendent, 3rd grade.
1 Supervisor, 45 inspectors, 550 *amins*, 7 computers, draftsmen, etc.

	Area in square miles.	Cost-rates per square mile. R
Traversing	843	57·1
Cadastral	876	96·5
Record-writing	963	30·9

There were 22,730 traverse stations of which 2,030 are marked with stones and the remainder with wooden pegs. Azimuth observations were made at 150 stations. The establishment of foreign *amins* that had hitherto been employed was reduced this season to 7 Inspectors and 28 *amins*, the cost-rate of the traversing is ₹13 higher than it was last season, and is due both to the small area traversed, and to the difficult nature of the country. Two large swamps or *bhils* which rendered the erection of the theodolite a matter of some difficulty were encountered and a part of the area traversed is intersected by numerous small rivers, and crowded with scattered homesteads surrounded by palm trees, which necessitated very short traverse lines. The swamps were inhabited by wild buffaloes, of which the surveyors were in much dread. The record cost-rate is not quite final as the statistical statements of 26 villages were not completed at the end of the season, but the combined rate for cadastral survey and records cannot exceed ₹130, a satisfactory reduction on that of last season which is chiefly due to the firm and good management of Mr. Bedford.

166. *Ránchi district.*—The operations in Ránchi were in continuation of those of last season and the outturn and cost per square mile were :—

	Area in square miles.	Cost-rates per square mile. ₹
Traversing	861	32·0
Cadastral survey	748	57·8
Record-writing	801	35·4

The season's traversing was connected with 2 stations of the Great Trigonometrical survey and the angular work was checked by observations for azimuth at 184 stations. The total number of theodolite stations is 20,077, of which 14,230 were marked with stones, 1,674 with a broad arrow cut *in situ* and 4,173 with wooden pegs. The cadastral survey includes a compact block of 34 square miles which was surveyed by *amins* who were under training. The writing of the records of the area of 179 square miles which remained over from last season was completed, but that of 91 square miles surveyed this season still remains to be done. Half the area surveyed cadastrally consisted of wooded hills with scattered patches of cultivation, the positions of which had to be fixed by plane-table intersections through dense jungle, and across ravines where chaining was impossible, but notwithstanding these difficulties and the poor average daily outturn of the *amins*, the cost-rates are very low, as cooly labour was supplied free.

Personnel.

Traverse.

Mr. T. W. Babonau, Extra Assistant Superintendent, 5th grade, in charge.
2 Supervisors, 39 sub-surveyors, 22 computers, etc.

Cadastral.

Mr. W. Skilling, Extra Assistant Superintendent, 5th grade, in charge.
Mr. H. W. Biggie, Extra Assistant Superintendent, 6th grade.
Mr. J. C. C. Lears, Sub-Assistant Superintendent, 2nd grade.
1 Supervisor, 34 inspectors, 482 *amins*, 11 computers, draftsmen, etc.

167. *Singhbhum district.*—The operations in this district were carried out by the Ránchi establishment and consisted of the traversing of the Saraikela and Kharsáwán estates, the area traversed being 600 square miles, of which about one-fourth is hilly and jungle-covered country. Out of 14,420 theodolite stations, 1,518 were marked by trijunction stones, 10,666 by ordinary stones, 1,839 by wooden pegs and 397 were cut *in situ*. The cost per square mile is ₹33·6.

168. *Calcutta Municipality.*—The survey of the added area of the Calcutta municipality on the scale of 50 feet to the inch was continued under Mr. R. B. Smart (retired). The area is 8,443 acres, but the survey of the adjoining area of the Panchánnagram Government estate has also been decided on and will be done in conjunction with that of the Calcutta suburbs. This additional area is 2,207 acres, of which 313 are to be surveyed on the scale of 1 inch=50 feet and the balance on the scale of 32 inches=1 mile. The outturn for this season is :—

	Acres.
Traversing	4,513
Detail survey	5,561
Record-writing	4,850

These figures added to those of last season show that 2,934 acres remain to be traversed and 1,111 acres to be surveyed in detail on the larger scale, and

1,762 acres on the smaller scale, while the records of 5,653 acres remain to be written. As no branch of the work is as yet complete, no cost-rates have been calculated.

169. *Bhágalpur Municipality.*—This survey with record-of-rights has been continued by one of the Bihár cadastral camps under Mr. Kraal. The total area is 12 square miles containing 33,371 holdings. The congested area, aggregating 1·3 square mile, was surveyed on the 64-inch scale on 23 sheets, and the balance on the 16-inch scale on 21 sheets. The municipal holding was taken as the unit of survey and given a number, while all items within the holding, such as tanks, houses, etc., were given separate letters. The expenditure was ₹306 for traversing and ₹7,857 for detail survey and record. Owing to a severe outbreak of plague the establishment had to be withdrawn from 23rd March to 14th June.

170. *Monghyr Municipality.*—The survey with record of this municipality was undertaken by No. 4 Party (Bihár) at the request of the Municipal Commissioners and the expenditure was met by them The congested portions only were surveyed on the 64-inch scale and the rest on the 16-inch. The total area surveyed was 3,680 acres, of which 910 were surveyed on the 64-inch scale. The total number of holdings was 18,266 and the average size of the holdings in the congested area was ·07 acre, and in the other portion was ·52 acre. Only the field work and mapping were completed, as the survey was carried on during the recess, and was much retarded by heavy rains and plague. The expenditure to the end of the season was ₹2,675.

171. *Miscellaneous surveys.*—The following minor surveys were also carried out under the Superintendent, Provincial Surveys.

(1) The re-traversing and demarcation of the boundary of *Mauza* Karaulia Bhasauli in the Bettiah sub-division of Champaran district.

(2) The re-laying of the boundary of *mauza* Darobast in the Monghyr district.

(3) The re-laying of the northern boundary of *mauza* Ghora *urf* Katora in the Patna district.

(4) The cadastral survey with record of *mauza* Chaparsan in the Darbhanga district.

(5) The completion of the survey on the 64-inch scale with record of the Roserha Municipality in the Darbhanga district.

(6) The traversing of the boundary of the Udaipur State, Chota Nagpur. One-half only was traversed this season.

Bengal Drawing Office.

172. The outturn of work in this office during the season has been far in excess of that of any previous season and as the work is still increasing, the office will shortly be moved into more commodious quarters.

Standard maps.—The 4 remaining sheets of Orissa have been completed and submitted for publication, also the 14 sheets of Chittagong and the following have been published:—sheets 135 to 137, 165 to 167, 169, 192, 194 to 197 and 219 to 223 of Orissa; sheets 409, 410, 411, 420, 423, 424 and 428 of Chittagong. Of Bihár the following sheets have been submitted for publication, Nos. 50, 78, 141, 142, 144 and 198 and sheets Nos. 84, 85, 109, 110, 112, 113, 114, 140 and 198 have been published during the season. The 9 sheets comprising the Darbhanga district are well advanced and will be published shortly.

District and Thána maps.—District maps of Muzaffarpur and Balasore have been completed and sent for publication on the ½-inch scale. That of Sáran has been completed, but publication is delayed on account of recent changes in boundaries. Those of Cuttack and Puri are in hand and the question of the preparation of the district map of Chittagong is under consideration as no material is available from recent surveys for a great portion of the district. The compilation of the Champaran district map awaits the publication of standard sheets 50 and 78 which have only just been sent for publication. All the *thána* maps of Orissa have been published with the exception of 1, while the 2 of Bihár that remained from last season should be ready for publication in October 1904. Those of Darbhanga could not be taken in hand, as none of the

standard sheets of that district have been published yet. Of Chittagong, the maps of 5 out of the 13 *thánas* have been published and those of the remaining 8 *thánas* are in hand.

Reproduction of village maps.—With the exception of 20, all the sheets of Orissa have been printed and 10 copies of each issued; the tracing of all the Sáran sheets has been completed; 5,389 sheets were traced during the season, 4,103 have been reproduced and 30,000 copies have been furnished to the Collector. A commencement has been made with the reproduction of the sheets of Muzaffarpur of which there are 6,560 and 10 copies of each are required; 2,000 have been traced only. In the Backergunge district 150 printed copies of each sheet have been asked for. This has necessitated a still further increase in plant During the season 789 sheets were traced, 497 were reproduced and 18,172 copies furnished to the Settlement Officer. Copies of the whole of the sheets of the first season's survey in this district, 1,050 sheets, will be supplied by the end of November 1904.

173. The system of reproducing village maps by the Vandyke process has been extended to the copies required at the attestation stage of settlement, as the field map is now drawn on paper which admits of reproduction by this process direct without the intervention of a trace. This procedure is found to be more economical than the system of preparing traces, as no examination is required. Three copies are supplied and are stamped "not final" to prevent the danger of their being mixed up hereafter with copies of the finally corrected sheets which will be supplied later on in the usual course. The number of sheets of the current season's work which were to be so dealt with was 6,648 but as this was more than the office could cope with, it was decided to print 4,429 sheets only, and prepare traces of the rest. During the season 5,558 copies were reproduced of 2,873 sheets. The balance will be completed during the early part of next field season.

174. The preparation of traverse charts on the scale of 1 inch=1 mile for the whole of the Bengal surveys has been commenced in accordance with Departmental Order (Professional) No. 19, dated 21st January 1902. Up to date only the computations of the co-ordinates of 3,445 villages of Muzaffarpur and 1,075 villages of Darbhanga have been completed. The Board of Revenue have also ordered the preparation of similar maps and a commencement has been made with those of Patna, Gaya and Shahabad, of which 4,695 villages have been plotted.

175. From the commencement of next season the 5 field detachments will be formed into 2 parties and numbered 5 and 6. The programme is as follows:—

Party.	District.	Traversing for cadastral survey.	Cadastral survey.	Record writing.	Topographical survey 4 inches=1 mile.	Traversing for topographical survey.
		Sq. miles.	Sq. miles.	Sq. miles.	Sq. miles.	Sq. miles.
4	Bhágalpur	1,258	40	40	85	...
	Purnea	711	1,633	1,633	176	...
5	Midnapore	...	21	135	...	...
	Ránchi	1,630	887	1,012	...	...
	Singhbhum	...	600	600	...	...
6	Backergunge	200	1,027	1,027	250	250
	Faridpur	1,600	...	...	...	...
	24-Parganas (Sundarbans)	...	...	...	300	300
	Totals	5,399	4,208	4,447	811	550

176. Major Crichton inspected each camp or detachment, on an average twice during the field season and again during the recess.

UPPER BURMA.

No. 7 PARTY.

177. The operations of this party were confined for the season to Upper Burma and were in continuation of those of the previous season in the districts of Pakôkku and Shwebo. The programme originally included the survey on a large scale of the added area of Rangoon, which, however, had to be postponed as it was found that no demarcation had been done by the local authorities. The establishment that had been assembled for the Rangoon town survey was, therefore, transferred to the Pakôkku district and employed on both traverse and cadastral work. In connection with the preparations made for the Rangoon town survey, there was an expenditure of R4,163 incurred in moving the establishment to Rangoon from Mandalay and thence back to Pakôkku.

Personnel.

Lieut.-Colonel G. B. Hodgson, I. A., Superintendent, 1st grade, in charge from 8th March 1904.
Captain C. P. Gunter, R.E., Officiating Deputy Superintendent, 2nd grade, in charge from 13th October 1903 to 7th March 1904.
Mr J. S. Swiney, Extra Assistant Superintendent, 2nd grade.
Mr. O. D. Smart, " " " 4th "
" C. Graham Lee, " " " 5th "
Babu Jagdamba Prasad, Officiating Extra Assistant Superintendent, 6th grade.
Babu A. C. Bose, Sub-Assistant Superintendent, 1st grade.
Mr. W. E. Swiney, " " 3rd "
17 Traverse sub-surveyors, 13 computers, 21 draftsmen, typers and estimators, 7 inspectors and 69 field surveyors.

178. The programme for the season was otherwise completed and the outturn is as follows :—

District.	Traverse survey.			Cadastral Survey, 16 inches=1 mile.						
	No. of *kwins*.	Square miles.	Cost per square mile.	No. of *kwins*.	No. of sheets.	No. of fields.	Acres.	Square miles.	Cost per square mile.	Average size of field.
			R						R	Acre.
Pakôkku	393	630 (a).	60	198	389	133,439	190,932	298	274	1·09
Shwebo	189	229	107	389	748	75,396	332,609	520	691	0·52
TOTAL	582	859		587	1137	208,835	523,541	818		

(a), Includes 65 square miles of river circuit.

179. *Shwebo district.*—The traversing was carried out under the supervision of Mr. Lee. Field work commenced on the 13th October 1903 and at the end of January 1904 the programme in this district having been completed, the traverse camp moved into the Pakôkku district. The area traversed consisted almost entirely of uncultivated land covered with scrub jungle and was in places undulating and broken, and in some parts hilly. The average number of traverse surveyors employed was 12 for a period of 92 days. Each man's average daily outturn for working days was 11 angles and 134 chains. No main circuits were measured. The new work was merely connected on to the traversing done in 1891-94. Most of the old work had to be re-observed, as a large number of the station marks were found to have disappeared. Thus out of 2413 of the old stations that were utilised, new marks had to be embedded at 1981. With the exception of 14, all the village traverses closed satisfactorily and in those that did not, the error was introduced from the old work as repeated remeasurements showed. There were 2 origins in the old survey. The intersection of longitude 95°30′ and latitude 22°30′ for the Ye-u sub-division, and of longitude 96°00′ and latitude 22°30′ for the rest of the district. All the computations have been completed.

180. The cadastral survey was carried out under Mr. J. S. Swiney with Babu Bose and Mr. W. E. Swiney as his assistants. Field work commenced on the 13th November 1903 and closed on the 30th April 1904. The average number of field surveyors employed was 33 and 3 native inspectors. Twelve of the *ámins* were Burmans, whose outturn is seldom equal to that of natives of India. The new work mostly formed a fringe to the old survey and was scat-

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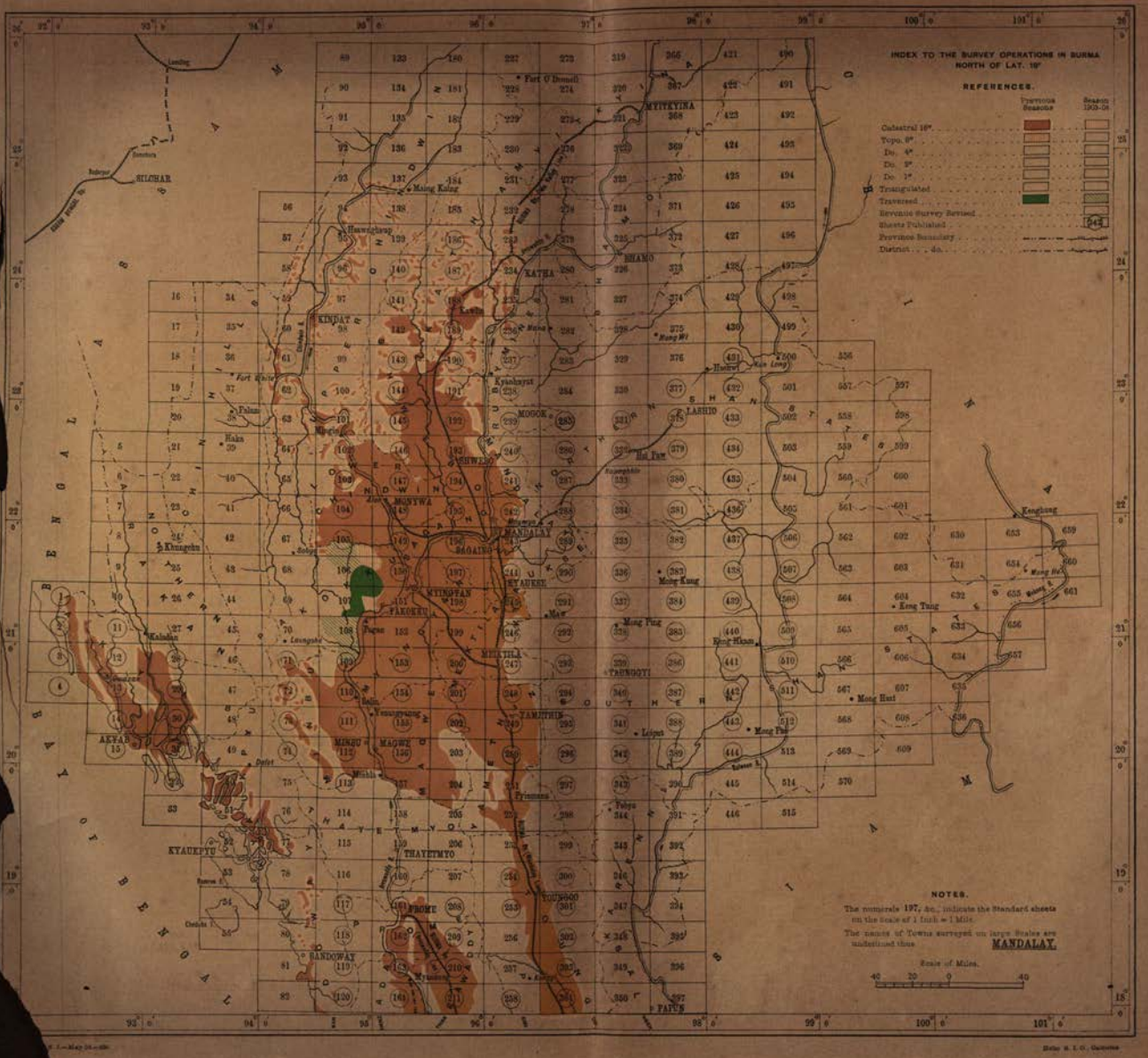


Reg. No. 841-S. 05.

INDEX TO THE SURVEY OPERATIONS IN BURMA SOUTH OF LAT. 18°

REFERENCES.

	Previous Seasons	Season 1903-04
Cadastral ... 16"		
Topo. Survey 8"		
Do. ... do. ... 4"		
Do. ... 3"		
Do. ... 1"		
Triangulated		
Traversed		
Revenue Survey Revised		
Sheets Published	582	
Province Boundary		
District ... do.		

NOTES.

The numerals 266, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

The names of Towns Surveyed on large Scales are underlined thus. RANGOON.

Scale of Miles.

40 20 0 40

tered in patches all over the district, some patches containing only one *kwin*, consequently a considerable amount of time was lost in moving *ámins* from one block to another. The total area that had been divided up into *kwins* was 520 square miles, but the greater portion of this area and many entire *kwins* contained no cultivation at all. All topographical details were mapped in and adjoining cultivation and elsewhere when forming *kwin* boundaries, but otherwise in waste land only the larger details were surveyed and the traverse lines were accepted as the *kwin* boundaries. The number of plots actually surveyed is 73,493 covering an area of 38,022 acres or 59 square miles which give 0·52 acre as the average size of the plot. The detail survey was tested by 312 linear miles of test lines by Imperial and Provincial officers and 97 linear miles of independent *partál.*

181. The fair mapping consisted of the insertion of the new detail on the 2-inch standard sheets compiled from the old survey. The additions are not sufficient to call for publication and the sheets will be forwarded to the head-quarters office for record until required for supplementary survey. Of the 16-inch sheets, 151 comprising 68 *kwins* have been forwarded to Calcutta for reproduction, and 30 copies of each of these have been furnished to the Settlement officer together with the area statements of 235 *kwins*. Traces of all the 16-inch maps were also furnished to that officer at the request of the Local Government: Neither the fair mapping nor the field sheets were quite completed during the recess, because wherever the new work touched on the old, it was found that considerable changes had taken place since the former survey. As *kwin* boundaries were affected in most instances, all such cases had to be referred to the Settlement Officer for decision as to the boundaries. The number of *kwins* affected was nearly half the number surveyed. The old boundaries were seldom upheld, consequently the maps and area statements of the adjoining *kwins* of the old survey have to be revised, and this will be taken in hand as soon as the mapping of the current season's work is completed. The sub-division of the *kwins* of the former survey continues, but has not assumed large proportions in this district. The number of *kwins* sub-divided during this season is 3 and the total to date 31 on 47 sheets which have been divided into 61 *kwins* on 67 sheets. Others are in hand.

182. The cost-rate for the cadastral survey has been calculated on the area actually surveyed as explained at paragraph 180. The rates are of no value as the survey was of an exceptional nature and the cost out of all proportion to the work accomplished, owing to the large extent of country over which this small area of cultivation was scattered and to the heavy expenditure involved in transporting full establishments to and from the district for such a small operation as it proved.

183. *Pakôkku district.*—The traversing of the Myaing township was completed and that of Seikpyu commenced. The general character of the country operated in was undulating and fairly open, but in some parts it was hilly and broken and covered with scrub jungle. Water was scarce almost everywhere. One camp composed of 6 traverse surveyors under Mr. Smart commenced work on the 1st November 1903 and early in February, 11 more sub-surveyors under Mr. Lee, moved into this district after completing the programme in Shwebo. Field work closed on the 25th April 1904. The average number of days each traverse surveyor was employed is 126 and their daily average outturn during working days was 12 angles and 151 chains. The chain measurements amounting to 1,671 linear miles were checked by connection with 4 stations of secondary triangulation, but the results have not yet been computed as the triangulation was carried out this season also and the co-ordinate values of the stations have not yet been received. All the circuits, however, closed within the prescribed limits, with an average chaining error of 0·48 link *per mille.* The computations cannot be completed until the co-ordinates of the trigonometrical stations are received.

184. Two camps were employed on cadastral survey in this district. One under Mr. Smart commenced field work at the end of November 1903, under the circumstances narrated at paragraph 177, but the second under Mr. J. S. Swiney which had been working in Shwebo, did not break ground till the beginning of March 1904, and field work closed on the 10th May 1904. The average number of field surveyors employed was 36 for 160 days under 5 native inspectors.

The character of the survey was the same as in Shwebo and the nature of the ground much the same as that met with by the traversers with the exception of a narrow strip of highly cultivated land along the bank of the Irrawaddy. Of the 298 square miles that came under survey, 220 consisted of cultivated land containing 141,015 acres and 129,694 fields: these figures give 1·09 acre as the average size of the field and 24 acres and 22 fields as the average daily outturn of each *ámin*. The survey was checked by 362 linear miles of test lines by Imperial and Provincial officers and 35 linear miles of independent *partál* averaging 1·8 linear mile to each square mile of the area actually surveyed.

185. All the fair mapping connected with the season's work was completed and one standard sheet No. 149 was sent to the head-quarters office for supplementary survey by No. 10 Party during the ensuing season. The drawing of sheets 150 and 151 was continued and completed as far as surveyed. These two sheets will be completed next season and will be available for supplementary survey the season after. Four new sections 105 S. E., 106 N. E., 107 N. E.-S. E., were projected and the season's work entered thereon. The original 16-inch maps of 90 *kwins* on 180 sheets have been sent to Calcutta for reproduction. The inking up and typing of all the rest has been completed, but they still require final examination.

186. The cost-rate for the traverse survey this season is much the same as usual, but that for the cadastral survey is exceptionally high. The latter rate is calculated on the area actually surveyed as given in para. 184, whereas in former seasons it has been taken from the whole area embraced by the operations. Following this procedure the rate comes to ₹200 *per* square mile which is still high and is due to the small outturn of one camp which had been originally told off for the Rangoon town survey and its native establishment had been considerably reduced. The average size of the field is somewhat larger than it was last year.

187. A sum of ₹1,605 is debitable to the Pakôkku town survey for the completion of the field sheets and area statements and preparing a wall map on the scale of 16 inches to the mile. The survey (which was done last season) was on the scale of 64 inches to the mile and occupied 7 *ámins* for an average of 80 days. The total area surveyed on that scale is 1,758 acres, of which 371 are occupied by houses. The number of plots is 9,980 and the total cost ₹5,034, which does not include the printing of the maps. This item will come to about ₹766 more and including this the cost-rate is ₹3·3 per acre. The field sheets have all been sent to Calcutta to be printed.

188. *Programme 1904-05.*—Next season the survey of the Pakôkku district will be continued; 600 square miles will be traversed in the Seikpyu and Pauk townships and 600 square miles cadastrally surveyed, completing the Myaing township. A survey on the scale of 100 feet to the inch will also be done for the Rangoon Municipality of an area of about 9 square miles of land recently added to the municipal area. This party will also take up the preparation of traverse charts for the whole area that has been cadastrally surveyed in Burma.

189. The Deputy Surveyor General inspected the party in February 1904.

UNITED PROVINCES OF AGRA AND OUDH.

No. 8 Party.

190. The operations in these Provinces remained under the supervision of Captain W. M. Coldstream, R. E., Superintendent of Provincial surveys, throughout the year. The outturn accomplished consisted of—

Topographical resurvey	114	square miles.
Traversing	270	„ „
Cadastral survey	507	„ „
Cadastral map correction	1,488	„ „
Record-writing	1,894	„ „
Town surveys	5	„ „
Road surveys	1,125	linear miles.

Twelve standard sheets, three district maps, and two traverse charts were submitted for publication. The work was carried out by one traverse and three cadastral camps and one drawing office.

UNITED PROVINCES.

INDEX TO CADASTRAL SURVEYS.

1903-04.

No. 8 PARTY.

Reg. No. 601-S. 05

UNITED PROVINCES.

INDEX TO THE TRAVERSE SURVEY.

1903-04. No. 8 PARTY.

Reg. No. 603-S. 05.

191. *Camp No. 1.*—In Moradabad, 269 square miles were traversed for cadastral purposes at a cost of R33·7 per square mile, and 114 linear miles of main circuits were run in advance along the high bank of the Ganges. The work was connected with three stations of the Great Trigonometrical survey, the errors so disclosed being 2·9 and 3·2 linear feet per mile. An area of 315 square miles in the alluvial tracts of the Ganges remains to be traversed next season.

Personnel.
Mr. F. S. Bell, Extra Assistant Superintendent, 5th grade, in charge.
5 Traverse sub-surveyors, 5 computers, 17 *amins*, etc.

192. The following towns were surveyed for municipalities on the scale of 64 inches to the mile.

	Sq. miles.
Muttra	2·86
Brindaban	1.17
Tánda Khas	·53
Barehta (Fyzabad)	·23
TOTAL	4·79

In Muttra and Brindaban, open ground was surveyed on the 16-inch scale and only the exterior limits of blocks of buildings were surveyed, while in Tánda Khas and Barehta, the whole area was surveyed on the 64-inch scale, and the interior limits of each house were also mapped. Record-writing was confined to certain columns of the field books and the preparation of area statements. The detail survey was based on a close net-work of traversing and was tested by an average of 12·3 linear miles and 57 acres of check survey per square mile. The cost-rate for the Tánda Khas work is R 4·7 per acre. As the other town surveys are still in progress, their cost-rates cannot yet be ascertained. The maps of Háthras, Sikandra Rao, and Atrauli towns, surveyed last season, were completed and printed, the combined cost-rates for survey, mapping, and record-writing, being As. 8·6 per acre for 16-inch survey, and R4.6 per acre for 64-inch survey.

The same camp also surveyed the boundaries and adjacent detail of 1,125 linear miles of first class roads in the Meerut and Lucknow divisions, for the Public Works department. The work was tested by 119·8 linear miles of check survey.

193. *Camp No. 2.*—Cadastral operations commenced in Moradabad in October 1903, and included an area of 593 square miles. Of this, 507 square miles, consisting of the alluvial tracts in Amroha, Moradabad, and Thákurdwára *tahsils*, were surveyed, and the maps of 86 square miles in the sandy tracts of Amroha *tahsil* were revised and corrected. Preliminary records-of-rights were written for 527 square miles. A small area of 20 square miles, part of an addition made to the programme late in the season, was also traversed. The cost-rates were R 46·9 per square mile for cadastral work, and R 17·6 per square mile for record-writing. The maps were tested by an average of 5 linear miles of check survey, and 20 per cent of the *khasra* entries were checked on the ground. The average size of fields was ·7 of an acre. Of the 270 *patwáris*, 203 proved competent to survey their villages, 39 were allowed to provide their heirs to do their work, and substitutes had to be appointed for 28 for survey, the records being written by the *patwáris* themselves. The work remaining to be done in this district consists of the correction of the cadastral maps of 250 square miles in the Amroha, Hasanpur and Sambhal *tahsils* and the cadastral survey of 315 square miles in Hasanpur which will be completed next season.

Personnel.
Mr. L. F. Berkeley, Extra Assistant Superintendent, 3rd grade, in charge.
„ J. H. Murphy, „ „ „ 5th „
19 Inspectors, 270 *patwáris*, etc.

94. *Camp No. 3.*—In the Bánda district, work commenced in October 1903, and consisted in the revision and correction of the cadastral maps of Bánda and Pailáni *tahsils*, with the preparation of annual *patwári* records. As was foreseen,

Personnel.
Mr. F. B. Powell, Extra Assistant Superintendent, 5th grade, in charge.
Babu Nilmoni Chatterji, Extra Assistant Superintendent, 6th grade.
16 Inspectors, 207 *patwáris*, etc.

MADRAS.

INDEX TO THE GODAVARI CADASTRAL SURVEY.

1903-04. DETACHMENT.

No. 607 S. I.—Mar. 05—300

Photo. S. I. O., Calcutta.

Reg. No. 656-S. 05.

when the operations were sanctioned, a considerable number of the villages had to be re-surveyed as the changes were too numerous to deal with by correction. This was carried out on plots of the old traverse data of 1871-77, the old station marks being found with very few exceptions. The total area of survey and map correction was 789 square miles, and that for which records were written 754 square miles. The difference is due to the large number of incompetent *patwáris* and the difficulty experienced in procuring local substitutes; it will not delay the sanctioned programme of operations, which prescribes the 1st of November as the date for commencement of attestation. On an average 3·84 linear miles of check survey per square mile have been run through the work, and 27 per cent of the *khasra* entries checked on the ground. Of 207 *patwáris*, 146 proved competent, 28 were allowed to provide their heirs to do their work, and substitutes had to be provided for 33. The cost-rates are R30·4 per square mile for cadastral correction and re-survey, and R10·6 per square mile for record-writing. The corrected maps have been traced for reproduction by the Vandyke process and will be printed within the next few months. Operations will close in this district in November 1907.

195. *Camp No. 4.*—In Hamírpur field work commenced in October 1903, and was similar to that carried out in Bánda. The survey and map correction of *parganas* Hamírpur, Sumerpur, and Maudha, 613 square miles, were completed during the year, and the annual *patwári* papers written for the same area. The amount of re-survey required was about the same as in Bánda, but the cost-rates are rather higher, being R40·5 for cadastral work, and R13·5 for record-writing, which is accounted for by the obliteration of almost all the old traverse station marks. This necessitated the temporary fixing of a large number of auxiliary stations from the trijunction marks, which fortunately were generally found well marked. The maps were tested by an average of 4·3 linear miles of check survey, and 24 per cent of the *khasra* entries were checked on the spot. Of 163 *patwáris*, 136 proved competent, 16 were allowed to provide their heirs to do the survey, and substitutes had to be provided for 11. Operations will close in this district in November 1906.

Personnel.

Mr. P. C. H. Smart, Extra Assistant Superintendent, 4th grade, in charge.
„ C. S. Littlewood, Sub-Assistant Superintendent, 1st grade.
17 Inspectors, 163 *patwáris*, etc.

196. *Drawing Office.*—During the season the drawing office has submitted for publication, standard sheets Nos. 6, 7, 8, 82, 83, 84, 98, 99, 100, 113, 114, and 192, and the district maps of Bareilly, Sháhjahánpur, and Lalitpur. The standard sheets were drawn on the 2-inch scale for reduction to half, from modern material with the exception of sheets 7 and 8 of which the old fair maps were corrected and revised. The remaining sheets of Meerut, 17, 18, 19, 30, 31, and 32, will be similarly revised and submitted next year. Sheet 89 (Farrukhabad) is in hand, and the standard mapping of Kheri, Bahraich, and Gonda will be proceeded with. Printed copies of the standard sheets of Hamírpur and Bánda will be corrected in the cadastral offices of those districts, and the original sheets will be afterwards corrected in the drawing office; those sheets which include portions of Allahabad, Fatehpur and Cawnpore being considered as most urgent.

Personnel.

Mr. J. M. Kennedy, Extra Assistant Superintendent, 3rd grade, in charge.
1 Sub-surveyor, 11 to 24 draftsmen, typers, etc.

Arrears Section.

Mr. W. C. Price, late Extra Deputy Superintendent (re-employed).
11 Draftsmen.

The one sub-surveyor attached to the office surveyed 114 square miles of the Jumna and Rámganga beds in sheets 7, 8, 68, 69, 84, and 85, during the season, and in conjunction with a sub-surveyor temporarily attached from No. 14 Party, revised the area including the town and environs of Agra in sheet 25, after the latter had revised the 4-inch military map of Lucknow.

An arrears section of the office was instituted in September 1904, to bring up the mapping of districts in arrears, and was placed in charge of Mr. W. C. Price, a retired Provincial officer.

197. *The programme for next season* consists of the topographical survey of the course of the Gogra in sheets 29, 30, 31, and 32, the traverse and

cadastral survey of 315 square miles in Moradabad, the correction of the cadastral maps of 2,000 square miles in Moradabad, Hamírpur, and Bánda, town survey in Cawnpore and Moradabad, and 1,146 linear miles of road survey in Oudh.

198. The Surveyor General and Deputy Surveyor General inspected the drawing office and traverse camp at Naini Tal in August. The Superintendent of Provincial Surveys inspected the office of each camp in the field and during recess, inspected and checked the cadastral work in progress in Moradabad, Hamírpur and Bánda, and the topography along the Jumna and Rámganga and examined and reported on the cadastral maps of the Ballia riverain areas.

GODAVARI DETACHMENT.

199. The origin of this survey and the nature of the operations were described in last season's annual report. The survey was commenced in 1901-02 when the whole area was triangulated. This season's field work commenced on the 10th November 1903, the early part of the season being devoted to traversing only as none had been done in advance the previous season, owing to the late date on which definite orders were received to take up the survey. Detail survey commenced at the end of January and was completed by the end of April, but the writing of the registers or *adangals* continued until the 10th July, when the detachment moved into recess quarters at Rajahmundry. The outturn for the season was 135 square miles, of which both traversing, detail survey on the scale of 16 inches to the mile, and record-writing were done. Again this season there was no demarcation although the necessary notices were issued ; only one dispute was registered however but this is probably due to the lack of interest evinced in the survey by the cultivators who would not attend even when the registers were being written up. The assistance of the Collector had to be invoked to compel their attendance as well as that of the village *kernáms* under whose superintendence the records were written and whose attendance was very irregular. The records were written by 8 *ámins* of the Mad ras Revenue Survey while 12 who were entertained locally were employed on revising the maps and registers of the previous season.

Personnel.
Mr. S. F. Norman, Sub-Assistant Superintendent, 1st grade.
5 Sub-surveyors, 2 computers, 1 draftsman, 54 *ámins.*

200. Numerous cocoanut and plantain groves added considerably to the amount of traversing required, necessitating a very large number of sub-traverses. The number of linear miles traversed was 295. The traverse stations were marked with wooden pegs as the whole area surveyed is subject to inundation, and permanent marks fixed by triangulation had been erected along the high banks beyond the reach of floods and the traversing was connected with these marks.

201. The detail survey was checked by 139 linear miles of test lines run by Mr. Norman including independent *partáls*, an average of a little over one linear mile to every square mile surveyed. In addition to this, 188 linear miles of test lines were run by native inspectors, who also checked 33 per cent. of the entries in the registers. The computations, mapping and area statements were all completed by the 15th November 1904, when the detachment was broken up.

202. Traces of the 16-inch maps were sent to the Surveyor General's office for reproduction, and orders are awaited as to the number of copies required. The original maps with copies of the registers were sent to the Collector for exhibition in his office for a period of 90 days, after which it is understood, they have to receive the approval of the Government of Madras before copies are printed. The original registers were sent to the office of the Superintending Engineer at Ootacamund.

203. The total cost of this survey from the commencement is R54,961, and the total area surveyed on the 16-inch scale, 265 square miles. These figures are subject to slight modification as the later accounts have not yet been audited. The cost is considerably higher than it would have been had timely orders been received to take it up, as it would then have been completed in one season. In any case the cost must necessarily have been high, as most of the establishment had to be imported from upper India. A sum of R2,646

had to be paid as compensation for trees that were cut down to enable the triangulation to be carried out.

204. The Deputy Surveyor General, Colonel Hobday, inspected the detachment in the field during May, and again during August at recess quarters.

ASSAM DETACHMENT.

205. The detachment continued traverse work and also carried out some boundary demarcation for the local administration. The actual areas traversed are shown in the following statement:—

Personnel.

Mr. T. Shaw, Extra Assistant Superintendent, 1st grade, Superintendent, Provincial Surveys, Assam, in charge.
Mr. G. J. S. Rae, Extra Assistant Superintendent, 6th grade, from 1st November 1903 to 24th June 1904.
Mr. C. A. O'Donel, Sub-Assistant Suprintendent, 1st grade.
20 Sub-surveyors, computers, draftsmen, etc.

District.	Number of villages.	Number of tea grants.	Area in square miles.	Remarks.
Darrang	...	21	15	For skeleton survey of tea-grants,
Nowgong	...	25	16	
Sibságar	...	4	4	
Lakhimpur	...	57	56	
Cachar	5	...	4	For cadastral survey.
TOTAL	5	107	95	

206. As in former seasons the traverses have been connected with those of the late No. 6 Party, and can be plotted in their correct positions on the standard maps. In the skeleton boundary surveys of the tea-grants in the Assam valley, 703 permanent marks for future topographical surveys have been fixed and 107 tea-grants have been located. The very poor outturn may be attributed partly to the scattered nature of the operations and partly to want of supervision in the field. Mr. Shaw was able to visit the sub-surveyors in Lakhimpur district only once and that late in the season, while Mr. O'Donel was employed throughout the season on boundary demarcation remote from the districts in which traversing was in progress.

207. The cost-rates are exceptionally high owing to the small outturn of work. In the Cachar and Sibságar districts where the areas were less than 4 square miles, the cost-rates were R283 and R253 a square mile, respectively. The following tabular statement gives the cost-rates per square mile by districts:—

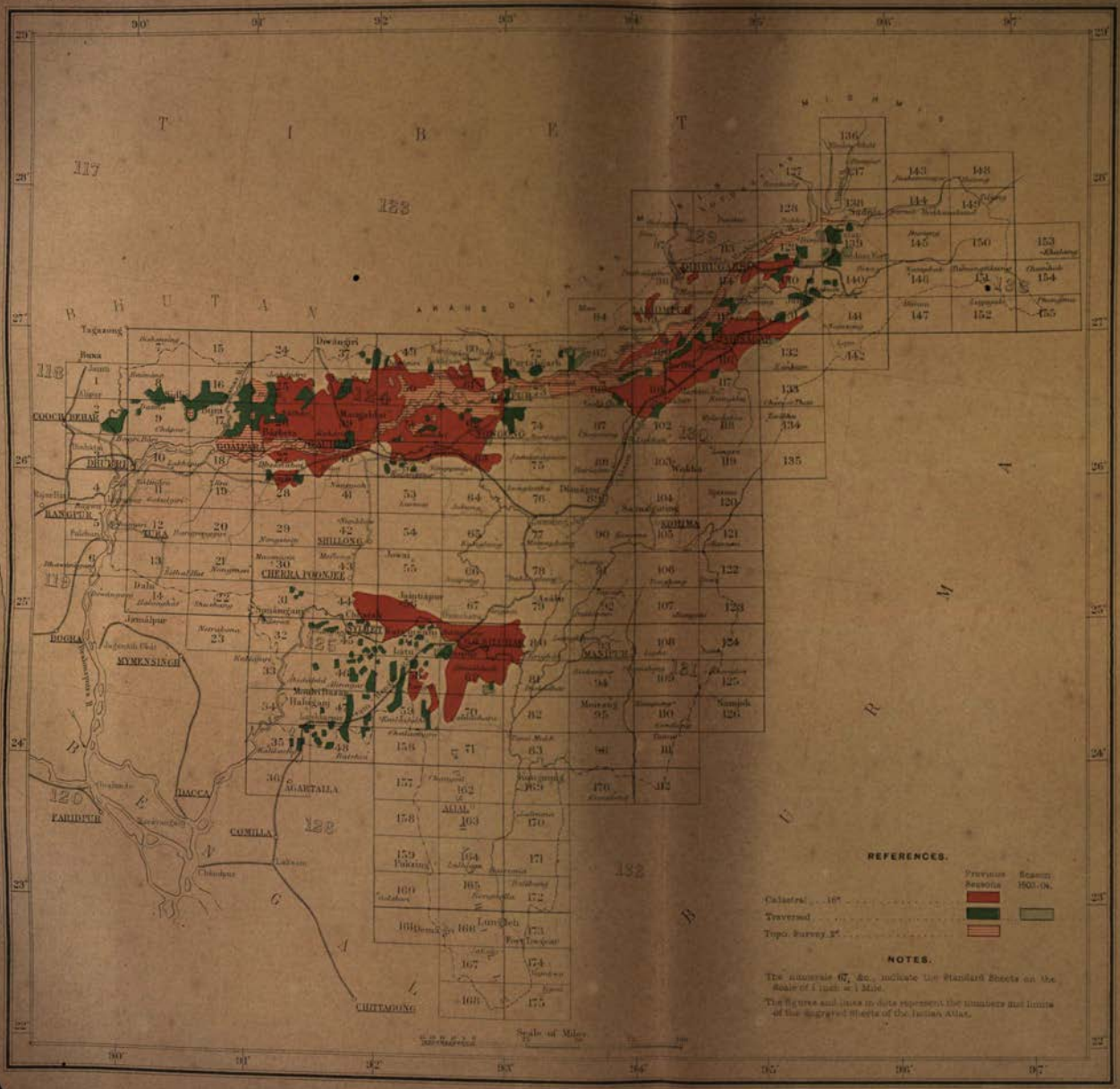
	R	
Darrang	100	Tea-grants.
Nowgong	139	,,
Sibságar	253	,,
Lakhimpur	113	,,
Cachar	283	Villages.

208. No topographical surveys were undertaken in the Province during the year. The preparation of standard maps was continued under Mr. Rae during Mr. Shaw's absence on tour, and 17 standard sheets on the 1-inch scale were submitted for publication during the season. The standard mapping of areas surveyed by No. 6 Party in Cachar and Sylhet districts has been completed and the mapping of Serail *pargana*, Tippera State, has been taken in hand to complete the maps up to graticule limits. In the Assam valley the areas surveyed by No. 6 Party have been completely mapped, and the work of making additions from surveys made since the formation of the Assam detachment is now in progress. The preparation of district maps on the scale of 8 miles to the inch for the Provincial Gazetteer and the maps of Goálpára and Kámrúp are well advanced. Information regarding boundaries of *mauzas* and communications in all districts is also being got together to meet the requirements of the Gazetteer Superintendent. When the gazetteer maps are finished it may be possible to reduce the strength of the drawing establishment.

ASSAM.

INDEX TO RECENT CADASTRAL, TRAVERSE, & TOPOGL. SURVEYS IN THE BRAHMAPUTRA & SURMA VALLEYS.

1903-04. ASSAM DETACHMENT.



No. 802, S. I.—Jan. 05.—500.

Reg. No. 659-S. 05.

Litho., S. I. O., Calcutta

209. A class for training local officers in practical field surveying was held at Palásbári in the Kámrúp district during February 1904. Mr. Shaw instructed one Assistant Commissioner, three Extra Assistant Commissioners and four Sub-Deputy Collectors. He also conducted an examination for first class certificates at the survey schools of Dibrugarh, Jorhát, and Gauháti and examined two pleaders in surveying at Sylhet. This examination was held to test the qualifications of pleaders for appointments as commissioners in civil suits as required by the High Court.

210. The programme for next field season is:—

District.	Traversing for cadastral survey by local agency.	Skeleton traversing of tea-grants.
	Sq. miles.	Sq. miles.
Kámrúp	15	16
Nowgong	...	3
Sibságar	...	5
Lakhimpur	...	108
	15	132

TRIGONOMETRICAL SURVEYS.

INDIA TRIANGULATION.

No. 24 Party.

211. The programme of work was to continue the Great Salween series southwards following the meridian of 98°30′ for its eastern flank, but this was interfered with by Captain Wood being deputed early in October to Nepal, to investigate the supposed identity between Mount Everest and a peak called Gauri-sankar. On his return in December it was decided, as the short season suitable for observing in Burma was so far advanced, to alter the programme, and the officer in charge was employed during the remainder of the cold weather in observing geodetic azimuths at some of the longitude stations of India and Burma. The Provincial officers were employed during the entire season in building stations for the Great Salween series, and so good was the progress made that stations have been built as far south as latitude 20°30′. At Quetta, in addition to observing an azimuth, Captain Wood observed an astronomical latitude, and in conjunction with Captain Pirrie at Nushki, a telegraphic longitude. Messrs. Troughton and Simms' 12-inch Theodolite No. II was used for the azimuth and latitude work. A synopsis of the results is given below:—

Personnel.

Captain H. Wood, R.E., Assistant Superintendent, 1st grade, in charge up to 2nd September 1904.

Captain H. H. Turner, R.E., Deputy Superintendent, 2nd grade, in charge from 3rd September 1904.

Mr. D. J. Hunter, Sub-Assistant Superintendent, 1st grade.

Mr. C. D. Simons, Sub-Assistant Superintendent, 2nd grade.

3 Recorders, 1 writer.

Azimuth Observations.

Station.	Latitude N.			Longitude E.			Value in seconds of difference in azimuth (Astronomic —Geodetic).	Difference in seconds of value obtained from stars of eastern and western elongations E.—W.
	°	′	″	°	′	″	″	
Jalpaiguri S.	26	31	15	88	46	41	−5	+0·03
Orejhár H. S.	26	46	56	82	14	35	−4·06	−0·66
Kyaunggyi S.	18	49	21	95	15	24	−7·80	−0·55
Bolarum P. W. D. Office S.	17	30	11	78	33	38	−1·1	+0·34
Deesa Tele. Office S.	24	15	30	72	13	33	−4·59	−0·62
Quetta Tele. Office S.	30	11	57	67	2	59	−4·86	+1·73

Latitude.

Station.	Geodetic latitude=C.	Astronomic latitude=O.	O—C.	Probable error.
	° ′ ″	° ′ ″	″	
Quetta Tele. Office S.	30 11 57·37	30 11 55·82	—1·55	±0·089

Longitude.

The difference in longitude between Quetta Telegraph Office S. and Nushki longitude S. is 0° 59′ 53″·55.

SCIENTIFIC OPERATIONS (GEODETIC).

ASTRONOMICAL LATITUDES.

No. 22 Party.

212. This party was employed on triangulation and latitude operations in the Himalayas, north of Mussooree. Questions of geodetic interest concerning the mass and attraction of the Himalaya mountains have been raised of recent years, and the programmes of the astronomical parties have been designed to obtain evidence on definite points. In 1901-02 and 1902-03, both astronomical parties were engaged in carrying latitude operations across the Ganges valley from the Vindhyas to the Himalayas, with the object of testing, as was explained on page 9 of the General Report of the Survey of India for 1902-03, whether a longitudinal region existed, running parallel to the Himalayas from Calcutta to Jodhpur, throughout which the deflection of gravity was southerly. The observations taken in those years showed that southerly deflections of gravity such as had been previously found to exist in the Ganges valley on the meridians of 77½ and 80, were prevalent, also on the meridians of 78½ and 88.

Personnel.

Major S. G. Burrard, R.E., Superintendent, in charge from 8th March 1904.
Captain H. M. Cowie, R.E., Officiating Deputy Superintendent, 2nd grade, in charge up to 7th March 1904.
Babu Hanuman Prasad, Sub-Assistant Superintendent, 1st grade.
1 Computer.

213. In April 1903 Captain Cowie was directed to observe for latitude at the Himalayan station of Birond to test whether the large deflections of gravity, which had been discovered at Dehra Dún and Darjeeling, would be met with also in Kumaun: the opinion had been expressed in Europe that these large deflections would be found to be local and exceptional, but as was pointed out on page 60 of the General Report for 1902-03, the Birond result has proved that large deflections in sub-Himalayan regions are the rule and not the exception.

214. In October 1903, Captain Cowie was directed to extend the Great Arc of India northwards across the Mussooree hills to the snowy range, and to observe for latitude at stations in the inner Himalayas. A high geodetic authority had expressed the opinion that the large deflections of gravity at Dehra Dún; Birond and Darjeeling were due not to the Himalayan mass, as had been assumed in the Survey of India Professional Paper No. 5 of 1901, but to the peculiar geological formation of the lower and outer range, and that they would be found to disappear when the first Himalayan range was crossed, and that large southerly deflections would be met with in the inner Himalayas. Captain Cowie added one tetragon and two triangles to the Great Arc of India, and extended it from latitude 30° 29′ to latitude 31° 1′ over a distance of about 35 miles. His triangulation emanated from Everest's side Banog-Sirkanda, and he observed horizontal angles at the stations of Kedárkánta, Lambáthásh, Bájámára,

Banog, Nagtibba and Báhak. Captain Cowie also observed for latitude at four of the Himalayan stations and his results are included in the following table:—

Series.	Station.	Height above mean sea-level.	Longitude.	Geodetic Latitude =O.	Astronomical Latitude =C.	Probable Error.	Deflection of plumb lins =O−C.
		Feet.	° ′	° ′ ″	° ′ ″	″	″
Great Arc Section 24° to 30°.	Dehra Dún, East end of Base.	1,958	78 1	30 17 7·35	30 16 37·29	±0·082	−30·06
	Dehra Dún .	2,289	78 6	30 19 57·07	30 19 19·56	± 0·18	−37·51
	Rájpur . .	2,997	78 8	30 23 56·67	30 23 9·33	±0·108	−47·34
	Mussooree . .	6,937	78 7	30 27 40·55	30 27 4·02	±0·104	−36·53
N. W. Himalaya Series.	Báhak, H.S. .	9,715	78 16	30 45 5·28	30 44 37·54	±0·102	−27·74
	Bájámára, H.S. .	9,681	77 56	30 45 56·07	30 45 27·92	±0·077	−28·15
	Lambáthásh, H.S.	10,474	77 57	31 1 7·65	31 0 35·20	±0·099	−22·45
	Kedárkánta, H.S.	12,509	78 13	31 1 22·09	31 0 51·21	±0·073	−30·88

215. It will be seen from this table that large northerly deflections continue to prevail in the heart of the Himalayas, and that no southerly deflections have been met with. It is unsafe perhaps to generalise from the observations of one locality, but Captain Cowie's results seem to indicate that a great disturbance of gravity exists over á large area—a disturbance which it is difficult to reconcile with Archdeacon Pratt's theory of Himalayan compensation.

216. The field-work of the party was closed prematurely as Captain Cowie was ordered to join the Tibet Frontier Mission.

217. The party was inspected by the Superintendent, Trigonometrical Surveys, in June 1904.

PENDULUMS.

No. 23 Party.

218. Up to December 14th, 1903, No. 23 Party was engaged, in combination with No. 22, on latitude operations, both parties being in Lieutenant Cowie's charge. On Major Lenox-Conyngham's return from leave he took charge of the party and the work undertaken was the revival of the pendulum observations which had been brought to a close in 1870.

Personnel.

Major G. P. Lenox-Conyngham, R. E., Superintendent, 2nd grade, in charge.
Babu Hanuman Prasad, Sub-Assistant Superintendent, 1st grade.
1 Sub-surveyor, 1 writer and computer.

219. The former determinations of the force of gravity were carried out at the instance of the Royal Society and with their pendulums. In 1901, it was decided that pendulum observations should be revived in India and an apparatus of Colonel Von Sterneck's pattern, including four half-seconds pendulums, was purchased. Professor Helmert, Director of the Central Bureau of the International Geodetic Association and of the Prussian Geodetic Institute, kindly undertook to procure and test the equipment and also to have the constants of the corrections determined. In October 1902, Major Burrard and Captain Lenox-Conyngham, who were on leave in England, went to Potsdam to study the use of the pendulums at the Prussian Geodetic Institute under Professor Helmert.

220. The next step was to select a base station, where the absolute value of gravity was known, and there to standardise the pendulums. Kew was chosen, as it had been the base station of the former series of observations, and at the suggestion of the Astronomer Royal and the Director of the National Physical Laboratory, a set of observations was made at Greenwich also.

221. The results of the observations at Kew and Greenwich are as follows :—

TABLE I.

No. of Pendulum.	137.	138	139	140	Mean.
	Sec.	Sec.	Sec.	Sec.	Sec.
Time of vibration at Kew .	0·5067070	0·5069490	0·5066104	0·5065339	0·5067001
Time of vibration at Greenwich	0·5067104	0·5069525	0·5066140	0·5065374	0·5067036
Difference . . .	0·0000034	0·0000035	0·0000036	0·0000035	0·0000035

A difference of 0·0000035 sec. in the time of a vibration corresponds to a difference in the intensity of gravity of 0·014 of a dyne, so that taking the value of g at Kew to be

Cm.
981·200

that at Greenwich becomes

Cm.
981·186

The probable error of this result may be estimated to be ±0·002. Cm.

The difference of g at Kew and Greenwich has been repeatedly determined, with the following results :—

		Cm.
Sabine 1831, Heaviside 1873	By determination of length of seconds pendulum	0·069
Herschel 1881	Kater's invariable pendulums Nos. 4 and 6	0·038
Constable 1888, Hollis „	Kater's invariable pendulums Nos. 4, 6 and 11	0·028
Putnam 1900	Three half-seconds pendulums . .	0·012
Burrard 1903, Constable „, Lenox-Conyngham 1903.	Four half-seconds pendulums .	0·014

222. The theoretical difference between the values of g at Kew and Greenwich according to the well known formulæ.—

$Y = 978{\cdot}000\,(1 + 0{\cdot}005310 \sin^2 \Phi)\,(1 - \frac{2H}{R})$ is 0·012

The agreement of the more recently observed results with the theoretical value tends to inspire confidence in the methods of observing which have now been arrived at, for it was difficult to believe that the value of g could be subject to marked variation in localities where no abrupt geological changes occur.

223. Immediately after the close of the work at Kew and Greenwich, Major Lenox-Conyngham embarked for India carrying the pendulums with him. The first work to be undertaken in India consisted (1) of a thorough standardisation at Dehra Dún, which is to be the base station for all India; (2) of a connection with several stations at which the old pendulums had been swung by Captains Basevi and Heaviside; and (3) of a commencement of the observations at stations situated in high mountains, which will form not the least interesting branch of the India pendulum operations.

224. In the following table the stations visited during the season 1903-04 are given, together with an abstract of the results: —

TABLE II.

Station.	Latitude.	Height above mean sea-level, h.	Observed g.	$g \cdot \frac{2h}{r} = A$	$g \cdot \frac{h}{r} = B$	Orographical corr. $= O$.	$+A+B+O = g_o$	Theoretical value at sea-level γ_o.	$g_o - \gamma_o$
Dehra Dún . .	30°19′29″	2,241	979·063	+·210	—·079	+·007	+·007	979·324	—·123
Madras, . . .	13°4′8″	23	978·281	+·002	—·001	0	0	978·266	+·016
Kolába . .	18°53′47″	32	978·632	+·003	—·001	0	0	978·545	+·089
Mussooree, Dunseverick	30°27′31″	7,131	978·778	+·668	—·251	...	...	979·334	...
Mussooree, Camel's Back	30°27′41″	6,924	978·795	+·649	—·243	+·027	979·228	979·333	—·107
Dehra Dún . .	30°19′29″	2,241	979·066	+·210	—·079	+·007	979·204	979·324	—·120

225. Calcutta was also visited, but Major Lenox-Conyngham found that it was impossible to take observations there, as the vibrations of the ground were so great as to set up in a few minutes sensible oscillations in the small pendulums of this apparatus. Captain Basevi's pendulums were four times as long as Major Lenox-Conyngham's, and it is probable that the earth tremors were of too short period to affect them, for the behaviour of clocks with seconds pendulums in Calcutta seems to be satisfactory.

226. The quantity $g_o''-y_o$ in Table II indicates the difference between the observed attraction of the visible mass and that which the latter would exert if it possessed a density equal to half the mean density of the earth.

The difficiency in g at Dehra Dún is such as would be caused by the subtraction of a layer 3,440 feet thick, and of a density equal to half the mean density of the earth, so that in estimating deflections of the plumb line, Dehra Dún should be regarded as being about 1,200 feet below sea-level.

TIDAL AND LEVELLING OPERATIONS.

No. 25 PARTY.

TIDAL OPERATIONS.

227. Observations were taken at the following tidal stations during the survey year:—

	Stations. (Those shown in italics are *permanent*).	Automatic or Personal observations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.	Remarks.
1	Suez	Automatic	1897	1903	7	Closed on 18th February 1904.
2	*Aden*	„	1879	Still working	24	
3	*Karachi*	„	1881	„	23	
4	Okha Point	„	1874 Restarted 1904.	1875	1	Opened on 22nd January 1904.
5	Port Albert Victor (Káthiáwádar.)	„	1900	1903	4	Closed on 21st April 1904.
6	*Bombay* (Apollo Bandar)	„	1878	Still working	26	
7	Bombay (Prince's Dock)	„	1888	„	16	Property of Port Trust.
8	*Madras*	„	1880 Restarted 1895.	1890 Still working.	10, 9 / 19	
9	*Kidderpore*	„	1881	„	23	
10	Bassein (Burma)	„	1902	1903	2	Closed on 1st January 1904.
11	*Rangoon*	„	1880	Still working	24	
12	*Port Blair*	„	1880	„	24	

228. The nine tidal observatories now working were inspected during the year; in addition to these Suez, Port Albert Victor and Bassein (Burma) were visited and finally closed. The registrations at all the observatories have been satisfactory.

Personnel.

Captain H. H. Turner, R. E., Deputy Superintendent, 2nd grade, in charge from 1st October 1903 to 28th September 1904.
Mr. J. P. Barker, Extra Assistant Superintendent, 4th grade, in charge from 29th to 30th September 1904.
Mr. H. G. Shaw, Extra Assistant Superintendent, 5th grade.
Mr. E. H. Corridon, Sub-Assistant Superintendent, 1st grade.
Munshi Syed Zille Hasnain, Sub-Assistant Superintendent, 2nd grade.
26 Surveyors and computers, etc.

229. Tidal observations have again been started at Okha Point in the gulf of Cutch after a lapse of 30 years, and the question as to whether any secular change has taken place round the gulf, will now be finally settled.

230. The two following tables show the annual and decadal percentages of the predicted time and height errors of high and low water at open coast and riverain stations.

Percentages of errors in predicted times and heights at open coast stations from automatic registrations.

Year.	Number of Stations.	In time.		In height.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1894	10	65	62	95	92	97	95
1895	9	68	65	98	97	94	94
1896	9	71	70	97	97	97	93
1897	8	71	75	96	97	97	97
1898	9	74	70	96	96	95	95
1899	9	74	06	95	95	93	92
1900	11	66	60	93	88	93	89
1901	11	71	60	93	91	93	91
1902	9	76	67	94	95	96	96
1903	8	80	77	92	93	91	94
Average of 10 years	9	72	67	95	94	95	94

Percentages of errors in predicted times and heights at riverain stations from automatic registrations.

Year.	Number of stations.	In time.		In Height.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1894	2	56	55	66	42	88	80
1895	2	59	55	74	47	94	84
1896	2	56	55	63	42	87	84
1897	2	59	61	75	57	96	91
1898	2	53	59	71	61	90	91
1899	2	55	59	76	65	95	94
1900	2	59	62	70	57	89	87
1901	2	63	65	70	59	90	92
1902	2	63	54	76	53	96	90
1903	2	55	61	70	60	88	87
Average of 10 years	2	58	59	71	54	91	87

231. The tide predicting machine has been moved to the National Physical Laboratory at Teddington and Dr. Glazebrook now supervises the tide predictions.

232. A reconnaissance of the coasts of the Malay peninsula about Kedah, on the west and Singora on the east, will be made next field season with the object of finding suitable sites for tidal observatories.

Spirit Levelling Operations.

233. The levelling detachment was employed in Burma and continued the line of levels from Shwebo to Wuntho on the line Sagaing to Myitkyina, where the work was closed and the detachment was then employed on the revision work between Mandalay towards Rangoon, and revised the old work up to Pyinmana.

The detachment then proceeded to Dehra Dún and levelled from Dehra Dún to Mussooree, and closed on the Great Trigonometrical survey station on the Camel's Back, 301·7 miles of double levelling were completed; this includes the revision work and the line from Dehra Dún to Mussooree.

The detachment left Dehra Dún on the 17th October 1903, and returned to recess quarters on the 30th May 1904.

234. During next field season the following work in connection with levelling operations will be taken up:—

(1) Levelling in Sind from Sujáwal to the Baháwalpur boundary.
(2) The reconnaissance of the road between Kedah and Singora in the Malay peninsula, in order to ascertain whether it is suited for precise levelling.
(3) The erection of standard bench-marks in the principal towns in the United Provinces of Agra and Oudh.

MAGNETIC.

No. 26 Party.

235. Five field detachments were employed in extending the work during the working season, in addition to which two Imperial officers divided between them the observations at repeat stations, the inspection of field detachments, and the comparison of instruments at the fixed observatories.

Personnel.

Captain H. A. D. Fraser, R.E., Deputy Superintendent, 1st grade, in charge up to 27th May 1904, and from 4th July to 31st August 1904.
Lieutenant R. H. Thomas, R.E., Officiating Assistant Superintendent, 1st grade, in charge from 1st September 1904.
Mr. H. P. D. Morton, Sub-Assistant Superintendent, 1st grade.
Babu R. P. Ray, " " 2nd "
Mr. A. M. Talati, " " 2nd "
" E. A. Meyer, " " 2nd "
Babu N. R. Mazumdar, " " 2nd "
3 Magnetic observers, 1 surveyor, 2 computers, 6 recorders, 1 writer.

236. The total of new work completed during the season amounted to 232 stations, in addition to which 24 old stations were revisited. The total number of stations so far occupied is 600 in three seasons' work, so that the fundamental survey is now more than half completed.

237. Lieutenant Thomas was fully trained in taking magnetic observations and the adjustment of magnetographs.

238. The results of the season's work are tabulated and published in the appendix together with an index chart showing the distribution of all stations of observation occupied up to date. The observatory at Dehra Dún remained in charge of observer Shri Dhar throughout the year, and there was no serious break in the records till September when, after continuous heavy rain, the underground room was flooded to a maximum depth of 22 inches and work was stopped for a period of 17 days altogether. It is hoped that the measures since taken will prevent a recurrence of the trouble, but in the light of past experience it is impossible to be quite certain. It is satisfactory to note that the instruments themselves have in no way suffered from the damp and are now giving as good results as formerly.

Numerous special observations of all kinds were made during the year at the Dehra Dún observatory.

239. The work at Kodaikánal observatory has not been completely satisfactory during the past year, as there have been several changes of observers owing to resignations, sickness and other causes, added to which the instruments themselves have given trouble. The observatory itself has not suffered from leaks, or excessive dampness, so that the measures taken last year to overcome these defects seem to have answered their purpose. In spite of this, however, the declination magnetograph again showed signs of interference in April 1904, and in the following month, Lieutenant Thomas opened up the instrument to discover the cause of it. He found nothing which could account for the lack of freedom exhibited by the magnet, but fitted new mirrors and a new suspension, and since then the instrument has behaved normally.

Regulations have been drawn up and adopted which define the relative responsibilities of the Director of the Solar Physics Observatory, and of the officer in charge of No. 26 Party (Magnetic) with regard to the magnetic observatory, and thanks are due to the former for his cordial assistance in all matters connected with the magnetic work.

240. The Barrackpore observatory has given satisfactory results throughout the year, and has been under the charge of observer K. N. Mukerji the whole time, except during his absence on sick leave from 25th January to

24th March 1904. The instruments have behaved well and the buildings have proved satisfactory except that the annual range of temperature in the magnetograph room is at present undesirably large. It has now been decided to ask for sanction to enclose the outer verandah entirely with wood and when this is done, the annual range should be considerably reduced.

241. In November 1903, the officer in charge inspected the buildings at Kokine near Rangoon, and made the necessary arrangements with the Public Works Department for the minor alterations which seemed desirable. A few months later and only a short time before the magnetographs arrived from England, intimation was received that it would be necessary to carry the alignment of the large cast iron main of the new Hlawga water-supply within a few feet of the existing magnetograph house. Enquiries were made and it was found that not only would it be impossible to alter the alignment to a safe distance at a reasonable cost, but that there was a project for laying a local railway line in the immediate vicinity which would probably be commenced at an early date. The only course open was to shift the site of the observatory to another locality and to erect the new buildings as speedily as possible. Towards the end of April 1904, the officer in charge proceeded to Burma and after selecting a suitable site at Toungoo, went to Maymyo where the preliminary financial arrangements were settled with the Chief Engineer to the Burma Government. The plans and specifications for the buildings were then prepared in consultation with Mr. Moran, the Executive Engineer at Toungoo, and the whole case sent to the Government of India for disposal. A few weeks later sanction to commence work was given, and thanks to the energy displayed by the Executive Engineer, the buildings are now ready to receive the instruments. The new buildings are entirely above ground and similar to those erected at Barrackpore where the conditions are somewhat similar. The instruments have arrived from England and will be in working order before the end of 1904.

242. The recess work commenced in May and owing to the accumulation of records at the base stations, proved exceptionally heavy. In order to cope with it, the Superintendent of Trigonometrical Surveys temporarily increased the strength of the party, and also added two computers to its regular establishment. The effect of these timely measures has been to bring practically the whole of the work up to date, and by making available the tabulated results from the base stations, to permit of an investigation of the reduction formulæ. This work has now been commenced by Mr. J. Eccles, M.A.

243. During the ensuing working season field work will be carried on by four detachments, partly along railways but chiefly in those parts of Central India and of the Madras and Bombay Presidencies which can only be reached by road.

The following season, 1905-06, will, it is hoped, witness the completion of the whole of India, west of the meridian of Calcutta, whilst the season 1906-07, should complete the field work appertaining to the fundamental survey.

TABULAR STATEMENTS.

Summary of the Outturn of Work of th

Calk of Survey.	Number of Party.	*Locale* of Operations.		TRIANGULATION.				1st Class.			Secondary.			Tertiary.		Spirit-levelling Operations		
				Instrument used. Diameter in inches.	Area in square miles.	Square miles to each point trigonometrically fixed.	Square miles to each height.	Stations fixed.	Triangular error in seconds.	Error per mile in feet.	Stations fixed.	Triangular error in seconds.	Error per mile in feet.	Intersected points.	Error per mile in feet.	Miles levelled over.	Permanent bench-mark stones embedded.	Other stations
105·6	Provl. Survey.	Calcutta Suburbs Survey	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
64 & 16	Provl. Survey.	Bhágalpur Municipality	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Monghyr Municipality	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
48 & 12	15	Cantonment Surveys	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
16	8 Provincial Surveys.	United Provinces of Agra and Oudh—Moradabad.	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	
		United Provinces of Agra and Oudh—Hamírpur.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		United Provinces of Agra and Oudh—Bánda.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	7 Provincial Surveys.	Pakôkku	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Shwebo	10	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Bengal—Midnapore	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		„ Bhágalpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		„ Purnea	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		„ Backergunge	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		„ Ranchi	15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		„ Singbhum	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		„ Miscellaneous	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	1	Central Provinces—Chánda, Seoni, Sambalpur, Raipur and Mandla.	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Det. 17	Godávari	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Bombay—Mátherán Hill Station.	20	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Total	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
8	17	Bombay Forests	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
6	18	Amritsar Town and Environs.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Simla (Forest Boundary Survey).	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Total	25	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
4	Provincial Surveys.	Bhágalpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Purnea	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Central Provinces—Hoshangabad.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Bengal—Singhbhum	...	6	201	2·9	2·9	...	...	...	5	23	0·5	55	0·8	...		
		„ Darjeeling	30	7	20	1·1	1·1	...	...	...	88	15	0·3	8	0·3	...		
		„ Angul	...	6	236	5·0	5·0	...	...	...	7	26	0·1	30	0·1	...		
		Assam—Kámrúp	...	5 & 7	296	0·4	0·4	...	...	...	32	14	0·3	104	1·1	...		
		„ Nowgong	...	5	65	2·0	2·0	...	...	...	16	22	1·3	16	2·3	...		
		„ Garo Hills	...	4·5 & 7	663	0·7	0·7	...	...	...	81	25	0·6	35	1·6	...		
	9	Punjab—Jhelum	35	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		„ Lahore	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		United Provinces of Agra and Oudh—Kumaun and Garhwál.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Burma—Ruby Mines	40	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		„ Salween	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		„ Katha	...	6	430	43	43	...	...	...	7	14	0·4	...	...	...	...	
		„ Mandalay	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Carried over			1,911													
					1,911													

ield Parties during the year 1903-04.

	TRAVERSING.					DETAIL SURVEY.					RECORD-WRITING.			Remarks.
	Area in square miles.	Linear miles of new chaining.	Number of stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error per mile.	Area in sq. mile.	Plane-table fixings per sq. mile.	Linear miles of test lines.	Villages.	Average size of fields.	Area in square miles.	Villages.	Fields.	
										Acre.				
...	7	119	3,756	...	...	8·7	...	..	...	...	7·6	...	6,939	(*a*) 1·3 sq. miles on 64-inch and 10·7 sq. miles on 16-inch scale.
...	3·0	15	295	...	...	12·0(*a*)	...	57	...	0·23	12·0(*a*)	...	33,371	(*b*) 910 acres on 64-inch and 2,770 acres on 16-inch scale.
...	5·8	55	1,248	...	...	5·8(*b*)	...	47	...	0·20	5·8(*b*)	...	18,266	(*c*) Includes 86 sq. miles of revision of old cadastral maps
...	8·8	...	...	...	...	17·8	...	...	...	...	...	...	...	(*d*) Revision of old cadastral maps.
5	...	..	...	...	...	59	...	...	...	...	...	...	...	(*e*) Excludes 150 sq. miles of water and river area.
...	270	990	5,971	4·0	0·6	593(*c*)	...	...	460	0·75	527	...	310,991	
...	...	...	...	...	...	613(*d*)	...	...	242	1·6	613	...	236,352	
...	...	...	...	...	...	789(*d*)	...	...	249	1·09	754	...	459,991	
...	630	1,671	12,853	2·7	0·5	298	...	807	198	1·09	...	...	133,439	
10	229	731	7,669	3·7	0·5	520	...	800	389	0·52	...	...	75,396	
...	22	102	852	...	...	621	...	2,845	1,678	0·74	486	1,281	426,740	
...	168	1,016	5,096	...	...	275	...	1,415	188	1·37	282	187	133,702	
...	1,997	8,431	48,582	...	...	1,499	...	7,722	1,193	1·15	1,499	1,193	832,151	
...	843	3,214	26,041	...	...	870(*e*)	...	3,745	898	0·96	963(*e*)	904	599,054	
15	861	2,453	22,443	...	...	748	...	2,712	559	0·92	801	599	559,039	
...	600	2,128	17,552	...	...	...	...	...	...	...	...	...	...	
...	38	...	1,511	...	...	8	...	...	...	...	8	...	5,440	
...	...	180	933	2·8	0·9	...	...	...	...	...	...	...	...	
...	135	...	2,177	1·9	0·35	135	...	327	23	1·09	135	...	44,052	
20	...	...	...	...	...	3	...	...	...	...	...	...	...	
...	5793	...	...	...	...	6,978	...	...	...	...	...	...	...	
...	...	...	...	...	...	158	197	72	...	...	...	...	...	
...	...	...	...	...	...	10·5	20	...	...	...	...	...	...	
...	...	...	...	...	...	14·5	62	...	...	...	...	...	...	
25	...	...	...	...	...	25	...	...	...	...	...	...	...	
	300	271	935	...	...	297	...	...	232	...	...	...	...	
	183	119	648	...	...	166	...	...	94	..	...	...	...	
	...	...	...	...	...	2·5	66	...	...	...	...	...	...	
	...	...	...	...	...	91	160	46	...	...	...	...	...	
	...	...	142	0·1	...	219	137	41	...	...	...	...	...	
	...	...	...	...	...	...	...	...	...	...	...	...	...	
	...	...	3,480	0·2	...	92	135	36	...	...	...	...	...	
	...	9	137	...	...	...	...	...	...	...	...	...	...	
	...	3	4,236	0·1	...	68	120	33	...	...	...	...	...	
	...	...	420	0·4	...	183	16	18	...	...	...	...	...	
	...	...	...	...	...	26	13	5	..	...	...	...	...	
	...	...	...	...	...	36	128	...	...	...	...	...	...	
	...	...	...	...	...	77	178	44	...	...	...	...	...	
	...	1,160	21,492	0·1	...	10	200	10	...	...	...	...	...	
						41	158	9	...	...	...	...	...	
						319	152	104	...	..	...	...	..	
	482					1,627·5								
	3,291·8					8,874·0								

Summary of the Outturn of Work of th

Scale of Survey.	Number of Party.	*Locale* of Operations.		Triangulation. Instrument used. Diameter in inches.	Area in square miles.	Square miles to each point trigonometrically fixed.	Square miles to each height.	1st Class. Stations fixed.	1st Class. Triangular error in seconds.	1st Class. Error per mile in feet.	Secondary. Stations fixed.	Secondary. Triangular error in seconds.	Secondary. Error per mile in feet.	Tertiary. Intersected points.	Tertiary. Error per mile in feet.	Spirit-levelling Operations. Miles levelled over.	Permanent bench-marks embedded.	Trigonometrical stations connected with.
		Brought forward			1911													
	17	Bombay Forests	...	6 & 7	677	1·9	1·9	...	...	...	296	16	0·6	1,388	0·6	...	...	...
	18	Multán and Muzaffargarh	45	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Muzaffargarh and D. G. Khan.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	19	Madras Forests—Godávari, Trichinopoly and Chingleput.	...	...	1,220	1·8	1·8	...	...	...	119	19	0·5	856	1·6	...	...	...
		Madras Forests—Kistna and Kurnool.	...	...	289													
		Madras Forests—South Canara.	...	...	428													
		Madras Forests—Coimbatore.	50	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	20	Burma Forests—Upper Chindwin. Lower Chindwin. Thayetmyo.	...	5 & 6	610	27·7	27·7	..	...	...	15	10·7	0·18	3	·2	...	...	...
		Total	...	...	5,135	...	...	...	...	...	...	...	...	...	...	...	...	...
2	1	Central Provinces—Saugor and Damoh.	55	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	8	United Provinces of Agra and Oudh—Meerut, Bulandshahr, Bareily, Budaun and Shábjahánpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	12	Sind	...	6 & 7	4,222	14	14	...	...	...	66	6·6	0·24	212	0·43	...	...	...
	14	United Provinces of Agra and Oudh—Allahabad.	...	6	650	6	6	...	...	...	12	15	0·33	88	1·1	...	...	...
		United Provinces of Agra and Oudh—Fatehpur and Cawnpore.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	15	North-West Frontier	60	6	1,460	24·7	24·7	...	...	...	59	10	0·25	574	0·25	...	...	...
	18	Multán, Amritsar and Baháwalpur State.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Ferozepore	...	...	....	...	...	...	...	...	...	...	...	...	...	...	...	...
		Total	...	...	6,332	...	...	...	...	...	...	...	...	...	...	...	...	...
1	3	Lower Burma	...	6	4,836	5	5	...	...	...	109	9·6	0·23	945	0·6	...	...	
	9	Darjeeling (Kalimpong)	...	7	20	1·1	1·1	...	...	...	8	15	0·3	8	0·3	...	...	
	10	Upper Burma	65	5 & 6	1,725	11	11	...	...	...	8	6·9	0·16	93	0·3	...	...	
	11	Upper Burma	...	6	2,714	12	16	...	...	...	46	29·4	0·35	527	0·5	...	...	
		Total	...	...	9,295	...	...	...	...	...	...	...	...	...	...	...	...	
½	Det.	Aden	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
¼	9	Bengal—Singhbhum	...	6	1,460	24·7	24·7	...	...	...	5	23	0·5	55	·8	...		
		Punjab—Dungagali	70	6	274	2·37	2·37	...	...	...	28	28	0·8	130	1·3	...		
	Det.	Aden	...	...	...	...	...	...	...	...	...	...	...	...	...	...		
		Total	...	...	1,734	...	...	...	...	...	...	...	...	...	...	...		
	Det.	Tibet	...	...	...	...	...	...	...	...	...	...	...	...	...	...		
	25	Tidal and Levelling	...	...	...	...	...	...	...	...	...	...	...	...	...	302(m		
		GRAND TOTAL	75	...	22,496	...	...	...	...	...	...	...	...	...	...			

ield Parties during the year 1903-04.

TRAVERSING.						DETAIL SURVEY.					RECORD-WRITING.			REMARKS.
	Area in square miles.	Linear miles of new chaining.	Number of stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error per mile.	Area in square mile.	Plane-table fixings per square mile.	Linear miles of test lines.	Villages.	Average size of fields.	Area in square miles.	Villages.	Fields.	
	6,291·8					8874								
	483					1627·5								
...	...	...	...	...	...	576	110	401	...	...	...	...	...	(*f*) Includes 96 sq. miles of re-survey in North Coimbatore.
45	3,441	3,545	9,152	4	3	...	...	...	...	...	...	...	...	
...	1,284					1,705	7	...	...	...	...	...	...	(*g*) Includes 35 sq. miles of overlap.
...	...	109	942	4·3	...	191	94	33 and in situ	...	...	...	...	...	(*h*) Excludes 253 sq. miles of detail survey and 11 miles of test lines not finally passed.
...	...	26	184	5·0	...	335	77	6 and in situ	...	...	...	...	...	(*i*) Included in 4-inch traversing.
...	...	9	149	...	...	174	151	125 & in situ	...	...	...	...	...	(*j*) Consists of— Multán=2,669 sq. miles. Amritsar=421 sq. miles. Bahawalpur State=82 sq. miles.
50	...	12	84	0·01	...	103 (*f*)	447	8 and in situ	...	...	...	...	...	(*k*) Includes 455 sq. miles of Supplementary Survey.
						457	180	243	...	...	...	...	..	(*l*) Includes 2,704 sq. miles of Supplementary Survey.
...	670	948	14,958	4·4	...	97	180	61	...	...	...	...	...	(*m*) Double levelling.
						117	180	43	...	...	...	...	...	
...	5,878	...	...	...	...	5,382·5	...	...	...	...	...	...	...	
55	...	...	...	...	...	2,874 (*g*)	5·9	280 & in situ	...	...	...	...	...	
...	...	...	...	...	...	114	...	...	...	...	...	...	...	
...	2,033	...	6,078	0·53	3·9	2,715	15	1,173	...	...	...	...	...	
						...	...	...	...	...	...	...	...	
...	2,911	7,892	38,079	0·01	2·6	2,221	29·7	583	...	...	...	...	...	
60	...	...	...	...	...	1,287 (*h*)	14	197	...	...	...	...	...	
...	(*i*)	..	(*i*)	...	...	3,172 (*j*)	6	...	...	...	...	...	...	
...	...	...	...	...	...	591	4	...	...	...	...	...	...	
..	4,944	...	...	...	...	12,974	...	...	...	...	...	...	...	
	193	...	...	...	...	2,603 (*k*)	10	109	...	...	...	...	...	
	...	...	142	0·1	38	...	...	...	...	...	...	...	...	
	...	335	1,065	5·0	1·1	3,005 (*l*)	11	1,034	...	...	...	...	...	
	...	...	...	...	...	3,153	...	12 and in situ	...	...	...	...	...	
	193	...	...	...	...	8,761	...	...	...	...	...	...	...	
	...	...	...	...	...	3,600	...	...	...	...	...	...	...	
	...	...	...	...	...	...	...	...	...	...	...	...	...	
	...	...	...	...	...	...	...	...	...	...	...	...	...	
	...	...	...	...	...	2,500	...	...	...	...	...	...	...	
	...	...	...	...	...	2,500	...	...	...	...	...	...	...	
	...	...	...	...	...	18,000	...	...	...	...	...	...	...	
	...	...	...	...	...	...	...	...	...	...	...	...	...	
	823·8	...	...	...	...	58,464	...	...	...	...	...	...	...	

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

Statement showing the cost-rates of work executed by the

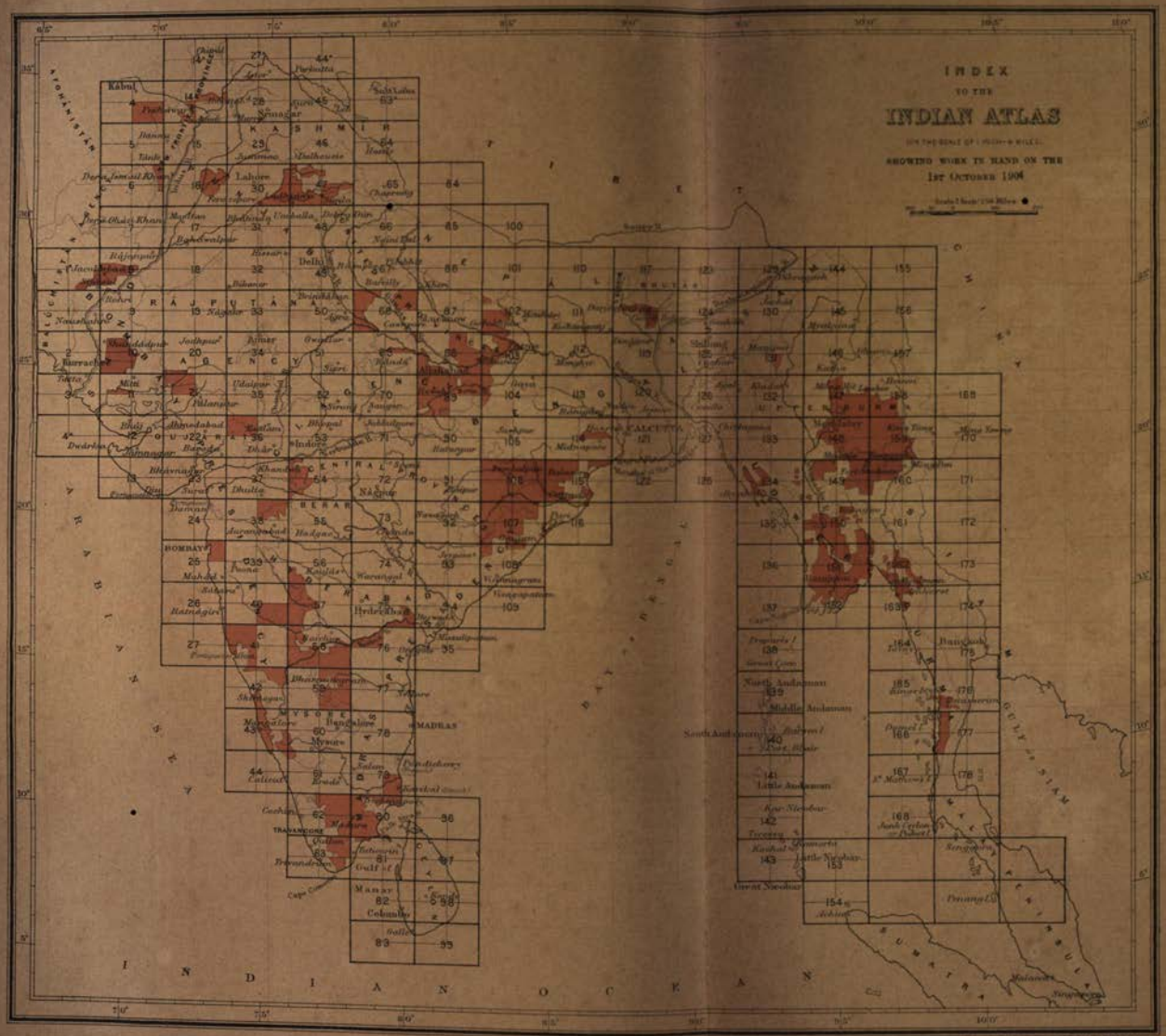
Number of Party.	Nature and *locale* of field operations.	Cost-rate per square mile.								
		Triangulation.	Traversing.	Detail survey and preparation of maps on scales of						
				1"	2"	4"	6"	8"	16"	48" & 12"	64"
	Topographical Surveys.	₹	₹	₹	₹	₹	₹	₹	₹	₹	₹
1	Central Provinces	...	...	...	10·8	...	...	...	...	...	...
3	Lower and Upper Burma (New Survey).	10·8	12·9	20·3	...	...	...	...	...	...	...
	Lower and Upper Burma (Supplementary Topographical Survey).	...	...	16·0	...	...	...	...	...	...	...
10	Upper Burma	10·5	10·7(*e*)	27·3	...	...	...	...	...	...	...
	„ „ (Suplementary Topographical Survey).	...	...	26·1	...	...	...	...	...	...	...
11	Upper Burma	10·0	...	25·3	...	...	...	...	...	...	...
Bengal Surveys.	Bhágalpur	...	25·6	...	...	16·8	...	...	...	...	...
	Purnea	...	16·4	...	...	13·5	...	...	...	...	...
12	Sind	3·2	10·0	...	13·8	...	...	...	...	...	...
	Berar	5·0	10·2	...	...	...	...	...	...	...	...
14	United Provinces of Agra and Oudh	2·6	17·4	...	9·8	...	...	...	...	...	...
15	North-Western Frontier	7·5	59·5 / 7·5	...	53·4	...	...	...	...	250·3	...
18	Punjab	...	5·2	...	...	8·7	14·1	...	...	...	...
	„ Supplementary	...	5·9	...	8·4	...	...	...	...	...	...
	Forest Surveys.										
9	Bengal	4·4	15·9(*e*)	...	...	64·0	...	...	...	...	...
	Gáro Hills, etc.	6·3	39·7(*e*)	...	...	85·2	...	...	...	...	...
	Lahore, etc.	2·2	3·5(*e*)	...	...	25·0	...	...	...	...	...
	Naini Tal	7·7	23·9(*e*)	...	...	27·1	...	...	...	...	...
	Hoshangabad	...	...	...	...	57·6	...	...	...	...	...
	Burma	8·7	13·2(*e*)	...	...	90·7	...	...	...	...	...
17	Bombay	15·3	...	...	...	67·5	...	138·8	...	...	...
19	Madras	9·2	19·5	...	...	102·2	...	...	...	...	...
20	Burma	7·4	44·5	...	...	135·7	...	...	...	...	...
	Cadastral Surveys.										
4	Bhágalpur	...	35·8	...	...	...	...	...	56·6	...	...
	Purnea	...	26·6	...	...	...	...	...	64·9	...	...
	Backerganj	...	57·1	...	...	...	...	...	96·5	...	...
	Ranchi	...	32·0	...	...	...	...	...	57·8	...	...
	Singhbhum	...	33·6	...	...	...	...	...	...	...	...
7	Pakôkku	...	59·7	...	...	...	...	...	274·2	...	...
	„ Town Survey	...	...	...	...	...	...	...	...	...	...
8	Moradabad	...	33·7	...	...	...	...	...	46·9	...	...
	Hamírpur	...	...	...	...	...	...	...	40·5	...	...
	Bánda	...	...	...	...	...	...	...	30·4	...	...
	Háthras, Sikandra Rao, Atrauli Town Survey.	...	...	...	...	...	...	...	...	...	2
	Tánda Khas Town Survey	...	...	...	...	...	...	...	...	...	...
Detachment.	Godávari	...	38·4	...	...	...	...	...	110·4	...	...

field parties during the year 1903-04.

Cost-rate per acre cadastral survey including traversing, detail survey and mapping.	Cost-rate per square mile.			Total cost inclusive of charges for instruments to Provincial Governments.	Remarks.
	Stone embedding.	Records (*Khanapuri*).	Completion of vernacular records, assessment statistics, etc.		
R a. p.	R	R	R	R	
...	...	...	...	49,388	(*a*) Cost included under head Cadastral Survey.
...	...	...	...	98,679	(*b*) Includes R17,170 expended on mapping and bringing up arrears of work.
...	...	...	...		(*c*) Includes R5,684 expended on arrears of mapping; and on leave pay of officers and Drawing Office charge of Superintendent's pay.
...	...	...	...	100,499	(*d*) Includes R9,444 expended on supplementary traversing; R1,760 on Simla City Survey; R582 on Ferozepore revision Survey; R18,679 on arrears and mapping; R1,250 on 6-inch Survey in Simla District.
...	...	...	...		
...	...	...	...	124,162	(*e*) Rate per linear mile.
...	...	...	...	(*a*)	(*f*) Includes R3,405 expended on 16-inch Survey of Mátherán Hill Station.
...	...	...	...		(*g*) Includes R1,771 expended on mapping and publication.
...	...	...	...	82,712	(*h*) Exclusive of printing of maps.
...	...	...	...		(*i*) Includes R2,752 expended on compensation for damages done to crops during triangulation in the previous season.
...	...	...	...	91,481(*b*)	
...	...	...	...	120,912(*c*)	
...	...	...	...	95,775(*d*)	
..	...	...	...		
...	...	...	...	23,501	
...	...	...	...	30,955	
...	...	...	...	6,125	
...	...	...	...	969	
...	...	...	...	144	
...	...	...	...	62,880	
...	...	...	...	74,594(*f*)	
...	...	...	...	107,701	
...	...	...	...	139,510(*g*)	
...	...	26·1	...		
...	...	36·6	...		
...	...	30·9	...	696,866	
...	...	35·4	...		
...	...	...	...		
...	16·4	...	...	206,680	
...	...	...	...		
...	4·5	17·6	...		
...	...	13·5	...		
...	...	10·6	...	120,392	
..	...	...	...		
...	...	...	...		
	...	3·8	...	23,900(*i*)	

Statement showing cost of Scientific Parties, Survey of India for Survey Year 1903-04.

Number of Party.	Name of Party.	Nature of Scientific Work.								Total cost of Party.	Remarks.
		Astronomical determinations.	Determinations of gravity.	Principal Triangulation.	Tidal Observatories.	Preparation of Tide Tables.	Levelling Operations.	Magnetic Observatories.	Magnetic field work.		
22	Astronomical	13,262	...	...	...	...	...	...	...	13,262	
23	Pendulum	...	24,656	...	...	...	...	...	...	24,656	
24	Triangulation	...	...	62,322	...	...	...	...	...	62,322	
25	Tidal and Levelling	...	...	...	20,925	19,408	22,263	...	...	62,596	
26	Magnetic	...	...	...	...	...	...	7,719	63,492	71,211	



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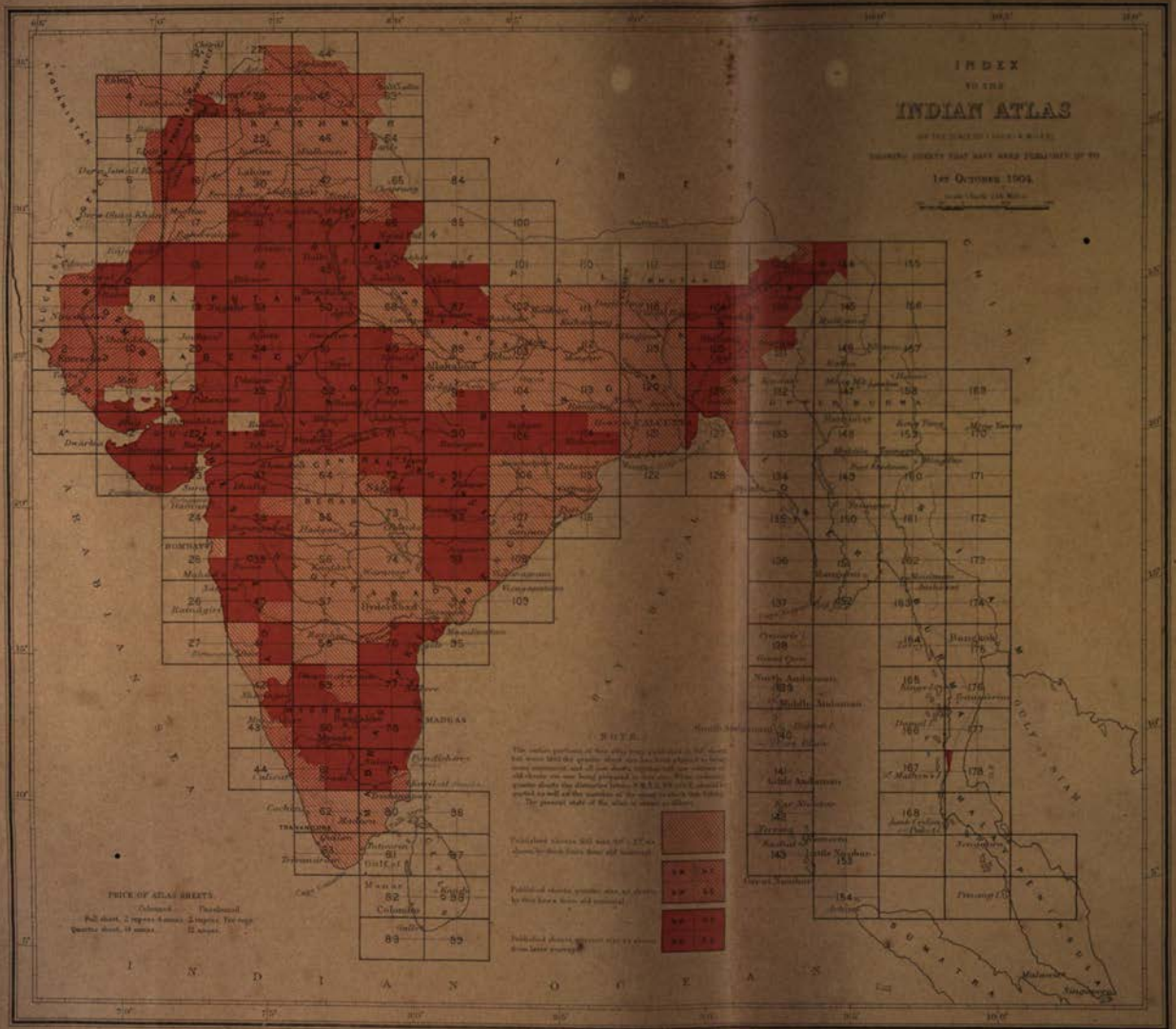

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APPENDIX.

Narrative Report of Captain M. O'C. Tandy, R. E., in charge Aden Boundary Survey Detachment, from December 1901 to July 1904.

From December 1901 to October 1902.

Lieutenant M. O'C. Tandy, R.E.
Sub-Surveyor Lal Singh.
„ Surveyor Mohamed Latif.
25 *Khalásis.*

The survey detachment, as detailed in the margin, was assembled at Dehra Dún on December 6th, 1901, but owing to the difficulty of obtaining 3rd class passages for the *khalásis* in through P. and O. steamers, a start could not be made from Dehra Dún till December 17th.

The detachment arrived in Bombay on December 19th, where it was met by Colonel Wahab, C.I.E., R.E., the British Commissioner, and two days later it embarked on the P. and O. *Oriental* reaching Aden on the morning of December 26th. The *khalásis*, who were not allowed to land till the 27th, were at once taken to the quarantine island where they were detained till the 30th, the two sub-surveyors were allowed to land on the 26th, but had to attend daily at the hospital for medical inspection till the 30th; quarters were provided for the party in an unoccupied barrack in the isthmus.

Owing to the non-arrival of the Turkish Commissioners a somewhat protracted stay in Aden seemed probable, and as it was also doubtful whether work would be commenced from the northern end of the proposed boundary line or from the sea-coast working northwards, Colonel Wahab decided to seize the opportunity to visit some of the Sheikhs along the coast; the R. I. M. S. *Minto* was placed at his disposal for this purpose, and the officer in charge with Sub-surveyor Lal Singh and some *khalásis* accompanied him; landings were made at four points from 50 to 80 miles west of Aden; owing to the shelving nature of the coast, landing was never easy and took a considerable time, and as only one night was spent on shore, it was never possible to penetrate far from the coast; one intersected point of the 1892 survey was visited, and some triangulation was done from this and from one new station on the coast, and in addition a few miles of the coast line were plane-tabled on the ½-inch scale. The party returned to Aden on January 12th.

On January 18th the Commission marched inland, it having been decided to commence work at the northern end of the boundary; on the 26th the Commission arrived at Dthala about 80 miles north of Aden where it had settled to meet the Turkish Commissioners; the road lay entirely through country already surveyed, so no new work was done *en-route* although for purposes of identification two old trigonometrical stations were visited.

It being considered desirable to have a larger scale map than the existing ½-inch one of the Dthala plateau and its approaches, Sub-surveyor Mohamed Latif was left on the 24th, two marches south of Dthala with instructions to resurvey on the 1-inch scale up to Dthala, and on the arrival of the Commission at Dthala, Sub-surveyor Lal Singh commenced on the same scale the country to the north of Dthala, a few extra trigonometrical points being fixed to assist in this work.

On January 29th, the officer in charge with Sub-surveyor Lal Singh and some *khalásis* visited Harir, a hill two marches north-east of Dthala, an intersected point of the old survey but unvisited till now; triangulation was commenced here, but owing to difficulties with the local Arabs only one station could be observed from; Sub-surveyor Lal Singh plane-tabled 16 square miles of new country and in addition was able to form an idea of the topography of a much larger area including the course of the Bana river; the detachment returned to Dthala on February 2nd; on the way, J. Shairi, a trigonometrical station of the old survey, was visited, but owing to dense clouds work was impossible: at this time of year these clouds hang about the lower valleys till after midday, rising gradually as the day advances.

Both sub-surveyors continued work on the 1-inch scale round Dthala till February 10th, when the officer in charge and Sub-surveyor Lal Singh revisited J. Shairi; a round of angles was observed, but on returning to camp letters were received from Colonel Wahab, ordering the detachment to return at once to Dthala instead of proceeding to the unmapped country to the north as had been intended, as the Turkish Commissioners who had arrived near Dthala on February 10th, objected to survey work in that direction claiming that part of the country as within their sphere. On February 15th Sub-surveyor Lal Singh was sent to work on the ½-inch scale in new country to the south-west of Dthala, and returned on March 7th, having plane-tabled 225 square miles.

Sub-surveyor Mohamed Latif also returned to head-quarters on March 7th having completed 48 square miles on the 1-inch scale, he found work in the low country to the south very difficult; the clouds lying very low down, work in the morning was impossible, and after midday the heat was very trying.

On February 18th, a party started with the intention of visiting Huria, an intersected point of the old survey on the Radfan range; three marches to the south-east of Dthala and previously unvisited; after slight difficulty with the local Arabs, a village within 2 miles of the top of the hill was reached, but from here owing to the open hostility of the natives who fired on the party, it had to beat a hasty retreat without doing any work; this failure was a great disappointment, as from these hills a large tract of quite new country could have been surveyed; the party returned to Dthala on February 25th, dropping Sub-surveyor Mohamed Latif on the road to finish his 1-inch work. Sub-surveyor Lal Singh was able to do a few days' work on the 1-inch scale after March 7th, making his total outturn on this scale 30 square miles, but with this exception no survey work of any kind was possible from March 7th to the present date (October 9th), work in every direction being stopped either by the hostility of the natives or in deference to the wishes of the Turkish Commissioners who object to any work being done near the boundary while the present negotiations are going on.

The health of the party has been good, slight malarial fever having been the only form of sickness, and the officer in charge and a few of the *khalásis* have been the only sufferers from this.

The climate of Dthala (nearly 5,000 feet above the sea) is mild compared to that of Aden; this year during the four summer months, May to August, the average maximum temperature has been 91°, and the average minimum 65°, with a rainfall of 17 inches, chiefly in the three latter months; during these four months and also in April and September, work in the low country near the coast and at any altitude lower than this would probably be impossible, but in the Yemen highlands (7,000 feet and upwards) to the north survey work should be possible all the year round. There are no complete data for the winter months, but from October to April inclusive the average maximum temperature here is probably about 82° and the average minimum about 51°.

At first 3 and later 2 military surveyors were attached to the Commission under Major Tod of the Quarter Master General's Department; they have made reconnaissance of several roads, all within the area already surveyed.

Resumé of work done.

New country on ½-inch scale	241 square miles.
Re-survey on 1-inch scale	78 „ „

From August 1902—April 1904.

The state of inactivity in which the last report left the Boundary Commission and which had commenced at the end of February 1902, continued until February 20th, 1903; during this long period the Commission remained halted near the town of Dthala, and the only survey work undertaken was some 5½ square miles on the scale of 4 inches = 1 mile; this was carried out in order to show possible camping grounds and wells near Dthala in view of the arrival towards the beginning of 1903 of a small supporting column.

During this halt near Dthala the surveyors were instructed in traingulation, and Sub-surveyor Lal Singh, who had some previous experience, was able to carry out the triangulation, and, with some assistance, the computations for the above mentioned large scale survey.

On February 19th, 1903, a short visit was paid to Jabal Jihaf, a high hill some 8 miles west of Dthala, which had been previously occupied by the Turks and which they had only recently evacuated; during the two days spent on Jabal Jihaf triangulation was extended, some new work completed on the ½-inch scale, and the first view was obtained of the country we were subsequently to pass through. On March 21st, Sub-surveyor Lal Singh commenced the survey on the ½-inch scale of the Humedi country to the south and south-west of Jabal-Jihaf; on the night of the same day (March 21st) the Turks evacuated the village of Jalela, which had till then been their head-quarters, and retired to the town of Ka'taba about 10 miles to the north-west. On March 29th, the British Commissioners advanced to Sanah (a small village about 1½ miles south of Ka'taba) in order to be near the Turkish Commissioners; this retirement of the Turkish Commission threw open to us for survey purposes, a considerable area of ground which we had not been able to visit before, and on his return from the Humedi country on April 3rd, Sub-surveyor Lal Singh commenced the survey of this on the 1-inch scale.

The triangulation had been extended as soon as we advanced to Sanah, and on April 5th, Sub-surveyor Mohamed Latif was able to commence the actual boundary survey. The Commissioners were not yet able to agree on any definite boundary line, so it was decided to carry out a survey for a distance of 2½ kilometers on either side of the lines claimed by the respective Commissions; on account of the large amount of detail that had to be shewn, the scale of $\frac{1}{40,000}$ was settled on for this boundary work, and further as the Turks had no means of carrying on an accurate survey, it was decided that we should carry out the survey alone, frequent joint examinations of the work being made to ensure accuracy. Work was carried out on these lines from April 5th—23rd when the Turkish Commissioners refused to allow the survey to continue until they had made some references to and received orders from their Government in Constantinople. Work on the boundary was consequently stopped.

On April 27th, Sub-surveyor Lal Singh commenced surveying on the ½-inch scale the country to the south and south-west of Sanah near which the boundary would pass; he was joined on May 1st by the officer in charge, and triangulation and survey were carried on to the south till connection was made with the work done by Sub-surveyor Lal Singh in February 1902 and March 1903. This party returned to Sanah on May 11th.

On May 17th, Sub-surveyor Mohamed Latif left the Commission to accompany a small punitive expedition advancing against some small tribes who had recently been giving trouble on the Aden line of communication; he rejoined at Sanah on May 27th, having surveyed some 70 square miles of new country on the ½-inch scale. During June and July reconnaissance work on the ½-inch scale was carried on of all the country visible from Sanah and Jabal Jihaf. Some hundreds of points being fixed by theodolite observations from short bases of from 1 to 1½ miles and in spite of haziness of the weather a fair idea was obtained of some 1,000 square miles of country which our surveyors are never likely to visit.

On August 31st, the entire detachment left the Commission to join a small force of 200 men and 2 guns, who were visiting the Shai'bi country to the north-east of Sanah; this tribe occupies the top and the north and north-eastern slopes of a long range of hills running approximately east and west which had previously, with the exception of a few isolated hill tops, stopped all view to the north; there was consequently plenty of work, both triangulating and plane-tabling, to be done, and work was carried on from camp near Awabil until September 3rd; on that day Sub-surveyor Mohamed Latif when working some 5 miles to the east of Awabil with a very small escort of six men had one shot fired in his direction; acting on his instructions he at once returned to camp; the following day the surveyor continued the work in which he had been interrupted, but accompanied by an escort of 50 men with a maxim gun, work progressed peacefully till on nearing the village of Hadára, about 40 Arabs appeared in front of the party on whom they fired, firing was brisk on both sides for some moments until the Arabs retired, but not before they had shot Sub-surveyor Mohamed Latif in the head and wounded one of his escort. Mohamed Latif was a very painstaking and hardworking surveyor and his loss is greatly to be deplored. A small column proceeded on the afternoon of the 4th to destroy the village of Hádara, and again on the 7th a larger party with gun-cotton completed the work of destruction; on neither occasion was any opposition met with. By September 8th, all the survey which it was possible to do from Awabil had been finished, and it was decided to advance two marches further north into the Rube'aten country; this was done on September 9th and 10th, a column of 200 men and two guns coming up from Dthala to occupy Awabil and keep open our line of communications; work in Rube'aten was finished on the 14th and a return was made on September 15th and 16th to Awabil. During our visit to Rube'aten the camp at Awabil was attacked from 7 A.M. to midday on the 13th by some 2,000 Arabs, who were however driven off with small loss on our side. On September 17th, the detachment returned to Sanah having surveyed about 200 square miles on the ½-inch scale, while with the help of many points fixed by theodolite from a short base in Rube'aten nearly 1,000 square miles was roughly sketched on the ½-inch scale.

On October 6th Mr. FitzMaurice and the officer in charge accompanied a Turkish column into the Mares country, and while living as the guests of the Turkish Commissioners a boundary line between Sha'ibi and Mares was agreed on and a few boundary pillars erected; for various reasons it was not considered advisable to survey this bit of country on the $\frac{1}{40,000}$ scale, accordingly an enlargement to this scale of the ½-inch work which had been done in the Sha'ibi country was made, and extra detail and corrections were applied to this; the party returned to Sanah on October 14th, having settled about 6¼ miles of the boundary; on October 24th work was recommenced on the boundary (scale $\frac{1}{40,000}$) where it had been left off on April 23rd, and continued without a break till November 22nd when a return to Sanah was necessary, as the Turks wished to observe Ramadan at Ka'taba. During this festival, *i.e.*, from November 25th to December 8th, Sub-surveyor Ahmad Hussen, who had joined the detachment early in November to replace Sub-surveyor Mohamed Latif, was employed on boundary survey (scale $\frac{1}{40,000}$) in the vicinity of Ka'taba and Sanah, and from these places connected his work with that previously done on the Mares-Sha'ibi border. On November 30th, Sub-surveyor Lal Singh left Sanah to continue the boundary survey to the south from the point where it had been left off on November 22nd.

By December 15th all boundary work near Ka'taba and Sanah had been completed, the boundary demarcated and pillars erected where necessary, so on December 16th the British Commissioners accompanied by one of the Turkish Commissioners, marched south following the course taken by Sub-surveyor Lal Singh, and halting from December 19th to 23rd near Al Husen on the Wadi Tiban, were able to examine Sub-surveyor Lal Singh's plane-table and to settle on a boundary line; meanwhile the officer in charge and Sub-surveyor Ahmad Hussen left Sanah on December 16th to revisit Jabal Harir, a trigonometrical point which had been visited in January 1902; during this second visit the triangulation carried out in Rube'aten was strengthened, a considerable area was sketched on the ½-inch scale, and Sub-surveyor Ahmad Hussen was able to re-survey and correct some sketch work of the 1902 survey; this detachment rejoined the Commission on December 23rd at Al Husen. On December 24th and 25th the Commission marched to the south and south-west to a camp near Ad Daréja leaving Sub-surveyor Lal Singh to follow on with the survey work; here new triangulation was required and it was not till January 9th that Surveyor Lal Singh, who had rejoined the camp at Ad Daréja on December

29th, was able to continue the boundary survey which he finished by January 22nd; it had meanwhile been decided not to continue the large scale ($\frac{1}{20,000}$) survey further south than Ad Daréja, but work only on the ½-inch scale, so on December 28th Sub-surveyor Ahmad Hussen commenced this work with orders to survey a minimum of 5 miles on either side of the boundary, to join up with the 1902 survey on our side, and to survey as much on the Turkish side as was possible.

From January 1st to January 6th, triangulation was carried on from hills on the Turkish side of the boundary with Mavia as a base, and during this time a large area was sketched on the ½-inch scale and a considerable amount on the ½-inch scale.

On January 20th, the Commission marched to Hawemi, and remained in this vicinity till February 6th; during this time both surveyors were fully occupied on ½-inch work; it would also have been desirable to do some triangulation from some high hills near here, but unfortunately the Turks were unable to arrange this. From Hawemi owing to the hilly nature of the country, and to the want of roads and water near the boundary, the two Commissions had to separate. The British Commission marching on February 7th reached Sanawi on the 16th, having halted two or three times on the way to allow the survey to be done; on February 9th, while on the march, the Commission met with some slight opposition from a small party of Arabs, but fortunately had no casualties.

The Turkish Commission (halted about 3 miles north of Sanawi) was met on February 17th, and from that date till the 24th February both surveyors were hard at work; by the 24th, however, all survey possible from this camp had been finished and the Commissions are now waiting until orders are received from their respective Governments enabling them to settle several small disputed points, and to fix a boundary from Hawemi to Sanawi.

At intervals there has been a large amount of office work in tracing and printing copies of maps; from 6 to 8 copies of all maps made for the Commission are always required and these have been printed either on bromide paper or by ferrotype process from over 50 P. O. P. negatives; in addition to maps for the Commission a large number of prints have been, from time to time, provided for the use of various supporting columns, probably 400 is an under-estimate of the total number of prints provided by the detachment.

Resumé of work done.

Scale 4 inches = 1 mile	5½	square miles.
„ 1 inch = 1 „	180	„ „
„ ½ „ = 1 „	1,600	„ „
„ $\frac{1}{40,000}$	140	„ „
Sketched on ½-inch scale	3,000	„ „

The health of the detachment during the period under report has been, on the whole, good; at the conclusion of the rains (*i.e.*, September) in 1902 there was a considerable amount of mild malaria which decreased during the cold weather, but broke out again in the spring of 1903; as a result of this malaria one *khalási* died at Dthala, and two others had to be invalided to India in March 1903 (one of these died within three weeks of reaching his home), while in June 1903 still another man had to be invalided; to replace these casualties six new men were obtained from India. From the summer of 1903, the health of the detachment has been invariably good, but in December 1903 (after the Commission had been nearly two years in the country) it was considered advisable to replace 12 of the men who had been with the Commission the whole time; this was accordingly done, the new men being obtained from India.

On account of outrages committed on the lines of communication, two or three small expeditions were undertaken during the winter of 1903; it is a matter for great regret that owing to pressure of work with the Commission, no surveyor was able to accompany any of these as it is believed no survey of any sort was done, while portions of the country visited were quite new.

From April 1904 to July 1904.

As previously reported the Commission arrived at Camp Sanawi on February 16th 1904, and although all the neighbouring country had been surveyed by the end of the month, a further advance was rendered impossible through the inability of the Commissions to agree on a boundary line; this state of inactivity was very greatly to be regretted from a survey point of view, as the rapid approach of the hot weather would render survey work exceedingly trying in the low-lying country through which the remainder of our work lay; on the other hand, however, there was a great deal of office work to be done in printing copies of the surveys of the Amiri and Haushabi borders, and during this halt at Sanawi these maps were completed. On April 6th, the chief points in dispute having been settled, it was decided to continue our work in a westerly direction along the Subaihi boundary; owing to the nature of the ground it was improbable that the two Commissions, each advancing through its own territory, would meet again for several days; it was, therefore, decided to attach one of our surveyors to the Turkish Commission and Sub-surveyor Ahmad Hussen was deputed for this work.

A start was made from Sanawi on April 7th, and after three days' marching, Surveyor Lal Singh working *en route*, the British Commission reached camp in the Wadi Adim

INDEX MAP
Areas Surveyed
On 1/2" Scale
" 1" "
" 1/40,000 "
" 4" "
Sketched on 1/4 Scale
SCALE 10 Miles = 1 inch
44° 0'
45° 0'
14° 0'
13° 0'
Yerim
W. Sch
W. Bana
W. Tiban
W. Sodan
Sa'Taba
Awabit
Al Hussn
Masia
Taiz
Ad Dareja
W. Waresan
Hawemi
W. Tiban
Sanawi
W. Jan Khabi
Lahej
W. Bana
ADEN
Perim
44° 0'
45° 0'

where a halt was made till the 12th. It was hoped that the Turkish Commission might meet us here, but as they failed to do so and as the water supply was both bad and insufficient, an advance was made (one march) to Mijza; here the Commission halted till the 19th, small detached camps being sent out to allow triangulation to be extended and enable Surveyor Lal Singh to survey not only the boundary but the large unsurveyed tract of country between it and the sea. On April 19th, the Commission marched to Mudariba where it halted till the end of the month, and here, on the 22nd, we were rejoined by the Turkish Commission; it was disappointing to find that Sub-surveyor Ahmad Hussen had been able to do very little work indeed while with the Turks; this, however, was not his fault but was due to the inability of the Turks to allow him to leave their line of march or to visit any of the high hills which enclosed it. From April 19th, when the Commission reached Mudariba to May 10th, the survey parties were continuously away in detached camps; Sub-surveyor Ahmad Hussen again working with the Turks, and the officer in charge and Surveyor Lal Singh continuing the triangulation and survey from camps at Turbat, April 25th—29th, Am Shat 30th, Ghail Barbar May 1st—3rd, Wadi Lassab 4th—7th, Wadi Hurim 8th—10th. By May 10th, the two Commissions were camped near Karba and here the survey parties rejoined them; after inspecting the survey work, the Commissions decided to again separate, the Turks marching *viâ* Bir Huneshiya to Shekh Said, while we were to march direct to Ras' Ara and from there embark for Perim; Sub-surveyor Ahmed Hussen still remained with the Turkish Commission while Surveyor Lal Singh worked his way down to the coast, *viâ* Wadi Hurim, Am Nabia and Ras'Ara. The British Commission reached Ras'Ara on May 21st, and at once embarking reached Perim on May 22nd; on the 24th, a boat was sent back from Perim to bring off Surveyor Lal Singh who had remained at Ras'Ara to finish the survey of the coast line. On May 25th, Shekh Said was visited in order to connect up the triangulation, and at the same time Sub-surveyor Ahamad Hussen was brought back to Perim; during his last stay with the Turkish Commission this surveyor had received considerable assistance from the Turks and had done some very useful work. The Turkish Commission being now settled at Shekh Said, and the British Commission at Perim, several meetings were held, and as the boundary line would in all probability pass through the peninsula of Shekh Said it was decided to survey it on the scale of $\frac{1}{40,000}$. Both surveyors were consequently sent to Shekh Said from the 28th—31st May. During their absence the triangulation was extended to Perim with the view of surveying the island on the 4-inch scale, the only existing maps consisting of naval charts; this work was carried out by Surveyor Lal Singh from 1st—7th June.

From as long bases as were possible between the mainland of Shekh Said and Perim, some 15—20 points on the African coast were fixed by theodolite in the hope that they might be picked up in subsequent surveys.

The triangulated values of the latitude and longitude of Perim differed respectively by about 12″ and 6″ from the values on the naval charts; it is a matter for great regret that owing to continuously cloudy weather it was impossible to obtain any satisfactory astronomical observations for latitude; an attempt to take circum-meridian observations was made on the only clear night, but as clouds came up before the completion of the observations, these were in no way conclusive.

From June 7th—15th both surveyors were employed in office work, and in finishing up their plane-table sections; on June 19th, leave having been obtained for the return to India of such portion of the survey detachment as could be spared, both surveyors and 15 *khalásis* sailed from Aden for Bombay, leaving the officer in charge and nine *khalásis* to finish the map drawing and to do any odd bits of survey work that might be required. This last detachment remained in Perim till July 7th by which date all the maps required by the Commissioners had been redrawn and printed, and on July 10th, it sailed from Aden with orders for the officer in charge to report to the Foreign Office in Simla.

The Officer in charge visited Dehra Dún from 20th—23rd July, in order to pay off the *khalásis* and return the instruments and stores to the Superintendent, Trigonometrical Surveys, and reported his arrival in Simla at the Foreign Office on July 25th, 1904.

An index map is attached showing the total areas surveyed.

Scale	4 inches = 1 mile	16	square miles.
"	$\frac{1}{40,000}$	219	"
"	1 inch = 1 "	166	
"	1 " = 1 "	3,643	"
"	1 " = 1 "	2,548	"

Preface of the Report on the identification and nomenclature of the Himalayan peaks as seen from Katmandu, Nepal, by Colonel St. G. C. Gore, C.S.I., R. E.

THE question of the name of the Indian Survey peak XV, the highest mountain in the world, is one which has given rise to considerable controversy.

When peaks are first fixed by the Survey of India they are given letters or numbers by the triangulator for purposes of identification and record. Subsequently enquiries are

made, and if a native name can be found which is really applied to the mountain in question that name is entered on the map. Failing a native name it has never been the custom of the Indian Survey to give fancy names, and the mountain remains known by its original distinguishing letter or number.

In the case however of peak XV, in 1856 Colonel Waugh, the then Surveyor General, finding no native name for the peak which on computation proved to be the highest known mountain on the globe, proposed the name "Everest," by which name it has since been known to the English-speaking world.

His Excellency the Viceroy having kindly interested himself in the matter, His Excellency Maharája Chandra Shamsher of Nepal gave permission for an officer of the Indian Survey to visit Nepal during the autumn of 1903, on purpose to identify and sketch the various peaks seen from the neighbourhood of Katmandu and try and settle the question of the identity of Gaurisankar.

Captain Wood has now visited the valley and has fully and accurately identified all the survey peaks that can be seen from the Kaulia hill, and also from the hill Mahadeo Pokra. In this report will be found a summary of the controversy which has arisen on the subject. It will be seen that the claim that peak XV should be called Gaurisankar, rests almost entirely on the evidence of Hermann Schlagintweit, who visited Katmandu in Nepal and also Falut on the ridge dividing Nepal from Sikkim. From both these places he drew panoramas of the view, and on each of these he marked a prominent peak as Gaurisankar, believing them to be one and the same peak XV. The name Gaurisankar he obtained from Maharaja Jang Bahadur of Nepal, and his pandits.

With Captain Wood's panorama of the view as seen from Kaulia before one, it is not at first evident why the Gaurisankar peak, which is in reality peak XX, should have been particularly chosen as the recipient of a name when the nearer and more striking groups to the north are nameless. The reason is, however, that from the town of Katmandu the snow mountains to the north are more or less hidden, and Gaurisankar, lying more to the east, is the most prominent of the snows visible. It has, therefore, become more familiar to the inhabitants of Katmandu than any of the other peaks.

On comparing Captain Wood's panorama taken from the top of Kaulia with that of Schlagintweit, it seems clear from the relative heights of the nearer and more distant ranges, that Schlagintweit drew his panorama from a somewhat lower elevation than Captain Wood did. This may account for the fact that the former shows no signs of peak XV (Everest) though it is visible from Kaulia as a low, insignificant peak in a gap, 2° to the right of the Gaurisankar peak. Everest is not visible at all from the valley of Katmandu, and it is only on ascending to some considerable height that its point comes into sight. In Schlagintweit's panorama, the nearer range cuts and obscures the southern slope of Gaurisankar, just at the point where the peak of Everest should have been visible.

Captain Wood gives a full account of his attempts to obtain names for the various peaks, and it is clear that the people of the country have no names which are generally associated with special peaks. The officials and those living in Katmandu, seem to have given the name Gaurisankar to the peak which is prominent from that point of view, though even this name is by no means a well known one. Whenever used it is, however, given specially to the Gaurisankar mountain and not to the group, His Excellency Maharája Chandra Shamsher who throughout took great interest in Captain Woods's work and gave him every facility to prosecute it, giving the name Gauri to one of the points and Sankar to another. The whole evidence collected by Captain Wood is quite against the theory that Gaurisankar is a name given to the mountain mass of which peak XX, which is the prominent point, is only one peak.

There now remains the further question whether peak XV (Everest) can be called a peak of the group of which peak XX (Gaurisankar) is the most conspicuous as seen from Katmandu or its neighbourhood.

Mr. Freshfield states that the point which he has been arguing throughout is "whether the 20,002 feet peak is among the snows visible from Kakani and known as Gaurisankar." This to my mind begs the question. General Walker was mistaken when he argued that Everest could not be visible from Kaulia. He did not allow for the deep gap in the range just to the right of peak XX (Gaurisankar). Through this gap the point of Everest just appears, as seen from Kaulia. This, however, in no way proves that Everest forms part of the group of which peak XX is such a prominent point.

Captain Wood took observations and photographs both from Kaulia hill 8 miles N.W. of Katmandu, and also from Mahadeo Pokra hill 14 miles east of the town. Outlines of the Gaurisankar group from these two points carefully enlarged from photographs and on the same angular scale are herewith given. A comparison of these is instructive. In the view from Kaulia the top of Everest is shown just visible over the gap at the southern foot of peak XX. Turning to that from Mahadeo Pokra we find that the shift of point of view has had the effect of moving Everest (not very much larger although 18 miles nearer) a long way to the right and completely dissociating it from peak XX. How can this great shift be reconciled with the contention that Everest forms part of the Gaurisankar group?

The same fact could be anticipated from the study of the sketch map of eastern Nepal which is given herewith. Peak XX (Gaurisankar) is one of a great group of peaks the principal of which are XIX and XX between 23 000 and 24,000 ft. in height. Thirty-six miles to the east of peak XX, but separated from it by the upper end of the Dudh

Kosi valley, stands Everest, which with peak XIII (Makalu) forms a separate group. The two groups are joined by a ridge running round to the north over which the road passes by the Pangu-a from the Dudh Kosi valley to Dingri, but to call these two groups one and the same is to my mind quite untenable.

As showing how difficult it is to identify mountains without careful instrumental observations and calculation, it may be interesting to check Mr. Schlagintweit's identifications as entered by him on his panorama.

Schlagintweit's Identification.	True identification.	Error.	
		Direction.	Miles.
Gaurisánkar XV	XX	2°	36
Sankósi Peak XXI	XXI	Correct	...
Jibjíbia East Peak XXII	XXIV	7½°	3
„ Central Peak XXIV	S31	5½°	5
Daibúng XXV	XXV	Correct	...
'Aku S. Peak XXVII	No such high peak exists where shown.		
Yássa N. Peak XXX	S_{12}	34°	34
„ S. „ XXVIII	S_8	33°	20
Dhavalagíri XLII	M_4	25°	74
Narayáni LI	XXX	24°	81
Machipúcha XLVII	XXVIII	22°	83

I cannot account for the lofty peak which Mr. Schlagintweit drew and named 'Aku South peak. There is no trace of such a peak in reality.

It may be further noted that the peaks (XX and XIII) seen by Schlagintweit from Kaulia and Falut which he considered one and the same and named Gaurisankar, are no less than 47 miles apart.

As to Dr. Boeck's photographs and identifications which Mr. Freshfield brings forward as giving additional evidence on the point of the visibility of Everest from Kaulia, a comparison of Captain Wood's photographs with the enlargement of Dr. Boecks's photograph published in the Geographical journal, clearly shows that the peak he calls Gaurisankar, and which Mr. Freshfield thinks he can hardly be wrong in recognising as XVIII is in reality XXIV, a peak more than 30° to the left of the real direction of XVIII. If Dr. Boeck started on his identifications with this peak as Gaurisankar, it is not surprising that he found plenty of peaks more to his right to identify as Kanchinjinga, Kábru, etc.

I am afraid that those who trust to their appreciation of characteristic forms and their mountaineering instincts, as a means of identifying peaks from widely different points of view are apt to be frequently misled.

The conclusion which, on consideration of all the evidence, I have arrived at is that while there is no ground whatever for giving the name Gaurisankar to Mount Everest, there seems to be perhaps sufficient accord in the Nepalese designations to warrant our acceptance of that name for peak XX.

Report on the identification and nomenclature of the Himalayan Peaks, as seen from Katmandu, Nepal, by Captain H. Wood, R.E.

In 1856, when the then Surveyor General Colonel (afterwards General Sir) A. Waugh proposed the name of "Mont Everest" for Peak XV of the Great Trigonometrical Survey of India's list of the great Himalayan Peaks, the suggestion gave rise in geographical circles to considerable discussion as to whether this peak had a native name, and if so, what that name was, and this discussion has been renewed at intervals. Sir A. Waugh proposed first to the Government of India and then to the Royal Geographical Society in London to give to this peak the name of his predecessor in office, because, though he had always scrupulously adhered to the rule of assigning to every geographical object its true local or native appellation, the Survey officers had not been able to discover, nor were they likely to be able to do so, any local name, and that as it was probably the highest mountain in the world, he had decided to name it after his late chief and to show that it was the peak alone that was so named and not the range he prefixed the word Mont and not Mount.

Six months later Mr. Hodgson, who was for 20 years Political Resident in Nepal, informed the Asiatic Society and also the Royal Geographical Society that the peak was not nameless, but that it was known in Nepal as Devadhungha. The former Society accepted the name Devadhungha and repudiated Everest. Thereupon Sir A. Waugh convened a committee of four officers to report on the matter, and their decision was published in the Proceedings of the Royal Geographical Society, Vol. 2, 1858. They decided that the identity between Everest and Devadhungha was not only not established but was also far from probable, and that Mr. Hodgson had written under the belief that the peak was so remarkable a feature that it would not have been creditable to him after 20 years' residence in Nepal had he been unable to identify it, but remarkable as the peak was from some points of view, from the parts of Nepal where Europeans were permitted to visit, the peak would probably be hidden by an intervening mass of mountains. The discussion

then dropped till 1862 when the Messrs. Schlagintweit published Vol. II, Hypsometry of their "Results of a Scientific Mission to India and High Asia." From this it appears that Hermann Schlagintweit from a point (Falut) on the Singhalila range (on the Sikkim Frontier) saw a very high snow peak in Nepal, and that in 1857 when he visited Nepal, he recognized this peak from a station, Kaulia—a point on the Kukani range, a few miles north-west of Katmandu—and that in Nepal this peak was called Gaurisankar, its Tibetan name being Chingopamari. This peak he stated was the one called Everest. In Vol. III he further remarks that prior to his visit to Nepal, Mr. Hodgson had made enquiries for him in Darjeeling about the name of this peak, and that the Nepalese called it Devadhungha, Bairabthan, Bairablangur, and the Tibetans Gualham, Taghlo Gualham and Taghlo, but that when he saw it from Kaulia every one called it Gaurisankar, and when questioned as to the other names they had given Mr. Hodgson, they averred they had not clearly understood which peak was meant.

Thereupon General Walker, R.E. (late Surveyor General), and, General Tennant, R.E., from Hermann Schlagintweit's panoramic profile of the snows from Kaulia and a chart of the geographical positions of the principal peaks and of Kaulia as given in Part II of the Schlagintweit Atlas, proved (assuming Schlagintweit's positions to be correct) by comparing the computed and observed azimuths that Everest and Gaurisankar were not one and the same peak. Their results were published by General Walker in the February Number of the Geographical Society's Journal for 1886 under the title "Notes on Mont Everest." At the same time Colonel Tanner, I.S.C. (of the Survey of India Department) published a paper in the Alpine Journal (February Number of 1886) on "The Highest Peak of the Himalayas." To this the Honorary Secretary of the Royal Geographical Society (Mr. D. W. Freshfield) added an appendix in which he decided that the peak called Everest was one and the same as seen by Hermann Schlagintweit and ascertained to be Gaurisankar and that the English designation *Everest* should be rejected. General Walker replied, but Mr. Freshfield remained unconvinced, and the matter remained unsettled as before.

In Petermann's Mitteilungen No. II of 1888 Emil Schlagintweit (brother of Hermann), wrote an article "Uber den Namen des hochsten Berges der Erde," in which he gave a summary of the discussions which had taken place before this date, and also a learned dissertation on the meanings of the various names that had been suggested for the highest snow peak of Nepal, and he ended by suggesting Gaurisankar-Everest as the name for it. This article was translated into English and published with a reply by Colonel Tanner, together with several panoramas, by the Survey of India as a departmental paper and entitled "A few lines on Mount Everest." In this paper Colonel Tanner again maintained that Gaurisankar and Everest cannot be the same peak. This was replied to by Emil Schlagintweit in Petermann's Mittleiungen No. 10 of 1890 under the same title as his previous article. Nothing new was brought forward by him but he still was unconvinced and again pressed that the name Gaurisankar be used by the Survey of India in lieu of Everest.

The controversy then dropped till 1898 when Major Waddell, I.M.S., in an article in the Royal Geographical Society's Journal, Vol. XIII, discussed the naming of Everest and suggested a Tibetan name for the peak. To this Emil Schlagintweit replied in Petermann's Mitteilungen No. 2 of 1901. He gave another learned dissertation on the meanings of the Tibetan names, and though no new evidence was produced, he again repeated his proposals to call the peak Gaurisankar-Everest, though virtually admitting that the name of Gaurisankar is applied to the group and not to the peak.

No other article on this subject appears to have been written until March 1903, when in the Royal Geographical Society's Journal of that month Mr. Freshfield published an article "The Highest Mountain in the world." In this article a reproduction of a telephotograph from "Durch Indien im verschlossen Land Nepal" by Dr. Boeck is published. In this photo there is a peak which Mr. Freshfield identifies as No. XVIII, and over the northern flank of it appears a snowy mountain which he takes to be the peak XV (Everest). The highest point of this group was pointed out to Dr. Boeck as Gaurisankar, and Mr. Freshfield concludes by saying "I trust I have made it clear that the point I have been arguing throughout is whether the 29,002 ft. peak is among the snows visible from Kukani and known as Gaurisankar, and not whether Schlagintweit or Major Wilson or other observers have identified rightly the particular summit."

This is hardly in accordance with Mr. Freshfield's previous writings as in Schlagintweit's note "Uber den Namen,etc." published in Petermann's Mitteilungen No. II of 1888, he stated referring to Mr. Freshfield's appendix to Colonel Tanner's article in the Alpine Journal, that Mr. Freshfield established that the peak named Everest was one and the same as the one seen by Hermann and ascertained to be Gaurisankar.

Previous to the publication of this article Colonel Gore, R.E., C.S.I., Surveyor General of India, had interested His Excellency the Viceroy in the matter, and represented to him that the question could only be finally settled by sending an officer into Nepal with the necessary instruments for taking observations.

The Prime Minister of Nepal was, therefore, approached on the subject, and the Durbar having given permission for an officer of the Survey of India to visit the hills round Katmandu and to take the necessary observations I was deputed for the duty.

My instructions from the Surveyor General were to first visit one of the Great Trigonometrical Survey stations in the plains of Bengal to the immediate south of Katmandu,

from which the higher snow peaks had been fixed (Batwaia) T. S., Lat. 26° 49′ 51″, Long. 84° 59′ 2″, was the one selected) and from there to identify by means of their azimuths the various fixed peaks and to make sketches of them. I was then to march to Nepal watching the peaks when they were visible to notice the change in their appearance, and from Kaulia or—if that hill could not be identified—from some other of the peaks on the Kukani range observe an azimuth, and by interpolation with the theodolite from the peaks west of No. XXII, which I was able to recognize, obtain my position, checking this by an observed latitude. With the co-ordinates of the point of observation thus obtained and those of all the Everest Group, I could work out the true azimuths of all and identify the peaks by means of setting the theodolite on the peaks in succession, and could check this identification by observing the vertical angles and working out their heights. I also was to make a panorama using the theodolite to plot all the prominent peaks, by measuring horizontal and vertical angles and filling in the detail by hand or, if permitted, by photographs. The names given by the country people to the groups or peaks were to be obtained, if possible.

I left Mussooree on the 2nd October reaching Segowlie on the evening of the 4th, accompanied by 1 native sub-surveyor and 14 *khalásis*, and took the following instruments. One 6-inch theodolite with stand by Messrs. Troughton and Simms (the limbs were read by 2 micrometers graduated to 10″ but which could be easily estimated to 1″), one Telescope by Messrs. T. Cooke and Sons with 3-inch object glass and fitted with pancratic eyepiece, 2 sidereal chronometers, 2 plane-tables with their fittings, 2 aneroids with 3″ dials, 2 thermometers, 1 Zeiss binocular telescope (prismatic), 2 field glasses, 1 whole plate camera with lenses of varying focus, and the necessary materials for developing the negatives and taking rough prints—also drawing instruments, rulers, papers, etc.

Unfortunately, early in October, an unseasonable cyclone which visited the eastern and central parts of India, giving large amounts of rain, flooded the country between Segowlie and Batwaia breaching the road in several places and making it very difficult to traverse. Though I left Segowlie early on 5th October, it was not till the 9th after many hardships and long marches that I arrived at Batwaia, though in ordinary times the march can be done in one day. Owing to the cloudy weather it was not until the 13th October that any view of the snows was obtainable, and then for only about half an hour at sunrise when a few of the peaks to the north were visible. Again on the following day at the same time they showed up but not very clearly. However, I was able to identify on the two days peaks Nos. XXII—XXX and XXXIII—XXXV, and to make rough hand sketches of them so as to fix their appearance in my memory. Those peaks lying to the north and north-west did not alter much in appearance as I advanced into Nepal, and were easily recognizable when seen from the hills round Katmandu. The delay at Batwaia re-acted on the work throughout as it was necessary that I should leave Nepal before the departure of the Resident about 15th November. Leaving Batwaia on the 14th October, I reached Katmandu on the 21st, and after a halt of one day there to collect coolies and to discuss the best places to visit with the Resident, I proceeded to Kaulia on the morning of 23rd. To understand the positions of the various places in the Nepal valley mentioned later on, it is necessary here to make a short digression to describe the valley. The Nepal valley is roughly elliptical in shape, about 20 miles in length by 12 in width, with its longer diameter lying approximately in a east-west direction. Katmandu can be considered to lie at the western focus of the ellipse. The valley is surrounded by a chain of hills, and for all practical purposes they can be considered as one range rising at places to peaks 7,000—8,000 feet high with low passes in between. Taking these peaks in order :—to the west lies Mount Nagarjun; to the north-west the Kukani range; to the north Sheopuri; north-east Manichur; east Mahadeo Pokra and south-east Phul Chowk (the highest of all the peaks surrounding the valley). The southern peaks do not come into this question and are not referred to here. The Kukani range consists of two peaks, the higher one Tokah lying to the east and joining on to Sheopuri, while the lower one to the west is called Kaulia. The lower slopes of Kaulia lie rather behind Nagarjun, and this hill cuts off the view from Kaulia of the western part of Katmandu. Kukani—the village from which the range takes its name and where a bungalow belonging to the Resident is situated—lies on a small elevation on the eastern slopes of the col connecting Kaulia and Tokah. This bungalow was built in 1869 or 1870, and replaced one situated almost on the summit of Kaulia, which was built during the time Mr. Hodgson was Resident—probably about 1824—and which was destroyed after the new bungalow at Kukani was built. The foundations of the walls of the old bungalow at Kaulia can still be traced, and it is most probably this bungalow which is mentioned by Hermann Schlagintweit as being close to his point of observation at Kaulia. With the view to occupying a position as near as possible to Schlagintweit's station I decided on observing from the highest point of the Kaulia hill, though this did not give the best view of the snows—Sheopuri being undoubtedly a better site. I had no difficulty with the aid of the sketches made at Batwaia, in identifying peaks XXII, XXIV—XXVIII, XXX and the more western ones XXXIII—XXXVI with the aid of my projected plane-table. I took latitude and azimuth observations on 3 nights. For the latitude on each night 8 to 12 observations were taken both to Polaris and to a south star at transit and for the azimuth 4 observations on each of 2 different zeros were made each night to Polaris and to ζ Ursae Minoris when they were near their eastern and western elongations respectively. Time was obtained each night by observing stars to the east and west close to the prime vertical. The results of the observations are given in the appendix. In the early morning and evening, spread over 3 days, 4 measures were made on each of 4 zeros of the angles between the peaks XXII, XXIV, XXV, XXVII,

XXVIII, XXX and the azimuthal referring mark; vertical angular measurements also were made to these peaks on the same days. These peaks were selected to interpolate my position from as I had not the slightest doubt of their identification and their summits offered the best points for intersection.

On the completion of the observations, the astronomical latitude and the azimuth of the referring mark were computed, and by applying the angle between the referring mark and the various peaks the azimuth of the peaks themselves obtained.

Then by taking from the plane-table the distances between the point of observation and the peaks, and using the astronomical latitude and azimuth, an approximate ΔA^* for each peak was computed, and thus the approximate azimuth of Kaulia (the point of observation) from each peak obtained.

As the distances between and the azimuths of each peak from the others had been already computed, an approximate value of the angle subtended at any peak between Kaulia and any other peak could be obtained.

The 6 selected peaks were then divided into 2 groups—XXII, XXV, XXVIII, and XXIV, XXVII, XXX, and from each group 3 sets of 2 triangles were formed to give a double value for each of the sides of the triangles—then using in successive traingles the approximate value of the angles subtended at each peak by Kaulia and the other peaks of the group, and the observed value of the angles at Kaulia between the peaks, values for the common sides were obtained. Considering the change in log-sine to be proportionate to the change in the angle, the approximate angles at the peak were corrected, so that the value of the common side obtained from each triangle should be the same. The computation was then made a second time, but the corrected angles were used in the places of the approximate ones, and a second approximation was obtained and the angles again corrected. A double value of each angle was thus obtained (one obtained directly by the computation and the second by subtracting the sum of the other 2 angles of the triangle obtained in the duplicate triangle from 180°). The mean of these 2 angles was accepted as correct. The Spherical excess of each triangle was then computed and applied to the angles of the triangle, and the 3 triangles of each group computed with these corrected angles, double values for each side being obtained; the mean being accepted as correct. With these values and the mean azimuth of Kaulia at each peak (obtained by applying the spherical angles (obtained from the computations) at any peak between Kaulia and the other 2 peaks to the azimuth of each of these peaks), the latitude and longitude of Kaulia were computed. Six values were obtained, each group of 3 being absolutely independent of the other, and the mean was accepted as correct. The close accordance of the values (*vide* Appendix) prove that no mistake had been made in the identification of the 6 peaks employed. Using the measured vertical angles and the computed distances of the peaks, and taking the co-efficient of refraction as 0·75† the height of Kaulia was obtained, the mean of the 6 values being considered correct. With the computed co-ordinates of Kaulia and the co-ordinates of peaks XV, XVIII, XIX, XX, XXI, (peaks XVI, XVII were undoubtedly not visible), the true azimuth of each was worked out. The theodolite was then set at the required azimuth and vertical angles taken to the peak to which the theodolite pointed. By these means peaks XV, XVIII, XX, and XXI were identified. Peak XIX was not visible. Subsequently further peaks were identified, for particulars *vide* Appendix I. While these computations were being done, vertical and horizontal angles were measured on both faces with the theolite to every snow peak visible, prominent or the reverse, and to most of their depressions, and changes of slopes and on one face to all the peaks, knolls, depressions, changes of slopes, etc., of the intermediate ranges. Photographs had also been taken at various hours of the day, some before sunrise and some just at, or after sunset, and some during the middle of the day. The positions of all the peaks, etc., obtained by the theodolite over 500 in number were then plotted on a prepared sheet of drawing paper. The cylindrical projection was used and a scale of 2° = 1 inch employed, and by means of the plotted positions of the principal peaks, etc., and of the photographs, a panorama of all the snows visible was drawn. This was then studied on the spot and, with the aid of the large telescope, the outline examined, and where necessary, re-drawn. Enlarged panoramas of the Gaurisankar group and peak XXIV were also made on the scale of 1° = 2 inches.

The work at Kaulia was finished on 5th November and the hill left that day. I then proceeded to Mahadeo Pokra from which point, I was informed by the Resident, the best view of the snows was obtainable, and similar observations to those taken at Kaulia were made and reduced. The only difference being that the observations were made on 2 days in place of 3, and that peak XXVI was used in place of XXII. The groups were arranged thus:—XXIV, XXVI, XXX, XXV, XXVII, XXVIII. This formed an entirely different grouping to that employed at Kaulia and was done as an additional proof of the correct identification, as, Kaulia being visible from Mahadeo Pokra, the observed azimuth of it could be compared with the one computed from the accepted positions of the 2 points.

From the value obtained for the place of observation, at Mahadeo Pokra, the following peaks were identified, XV, XVII, XVIII, XIX, XX, XXI, XXIII, etc. (*vide* Appendix 2).

The points of observation at Kaulia and Mahadeo Pokra were both marked with piles of stones and rock 6 ft. in diameter and 6 ft. high.

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* If A is azimuth of peak B from peak A, and B is azimuth of peak A from peak B. Then $\Delta A = (B - 180° + A.)$.

† At midday the peaks were always obscured by clouds and therefore the vertical angles could not be measured at the time of minimum refraction, hence a somewhat large co-efficient was employed in the computations.

A panorama on a scale of 2°=1 inch was also made at Mahadeo Pokra, of all the snow peaks visible and one on the scale of 1°=2 inches of the peaks near XV.

His Excellency Maharaja Chandra Shamsher very kindly wrote on a photo taken from Mahadeo Pokra, from which the view to the east is very nearly the same as that from Katmandu, (after having pointed out the hill to me from the window of his palace), which peak was known to the inhabitants of the valley as Gaurisankar. From this it appears that the name Sankar is given to that identified as peak XX and Gauri or Parbati to a lower peak not fixed by the Survey of India. His Excellency particularly told me the name was applied to these 2 peaks and not to the range. Peak XV (Everest) is invisible from Katmandu, or at least I was unable to identify it from any position in the valley at which I erected the telescope, and I tried at 3 or 4 different places. Nor from Chandragirhi or Seishagarhi, the 2 passes crossed on the way from Katmandu to Segowlie, could I identify the peak even with the aid of a very good pair of field glasses, and at the former I should add that the place where I expected to see the peak (Chandragirhi-Katmandu, Mahadeo Pokra are all approximately on the same bearing) was hidden by a small cloud when I crossed the pass on my return journey.

As regards the naming of the various peaks, I could discover nothing. The name Gaurisankar appears to be one given (by the nobles at Katmandu only) to the 2highest peaks of the group which is the only conspicuous one seen from the city (the one marked as Gaurisankar on Schlagintweit's panorama is peak XX), and I very much doubt if they could recognize it if seen from a slightly different point of view. At least the officer His Excellency Maharaja Chandra Shamsher sent up to Kaulia to point out this peak to me failed to recognize it, and said it was not visible from there; and even after I had pointed out the peak to him he said it was not Gaurisankar but a peak something like it. Every lower class native of the valley I asked did not know the peak by that or any other name, nor did they appear to give names to any of the snows at all. At Kaulia and at Mahadeo Pokra I had several, about ten in all, hill men brought to me who were supposed to know the names of the hills, and every one, without exception, gave different names to the same peaks, and none called the peak known in the valley as Gaurisankar, by that name. Very nearly every other peak visible was pointed out as Gaurisankar when asked, but with the exception of 2 men, both at Kaulia, none give the name Gaurisankar to any peak until they were asked which was Gaurisankar. My method of questioning was to lay a straight stick (I found they could use that better than the plane-table sight ruler) on the plane-table and tell them to point it in succession to the hills whose names they knew. At first I took down the names they gave but as each gave a different one, I did not think any reliance could be put in them and discontinued doing so. The 2 men mentioned above gave the name Gaurisankar, one to peak XXIV and the other to peak XXVIII. Peak XXIV is undoubtedly the one reproduced in the March Journal of the R. G. S. of 1903 from Dr. Boeck's work, and identified by Mr. Freshfield as peak XVIII. The peak appearing over the northern shoulder, which he fancies is peak XV, is most probably one of the minor peaks fixed by the Survey of India and known as S 33 (43 miles from Kaulia and 2 miles beyond peak XXIV, height 23,360 feet), but its identification is not perfect. It disappears behind peak XXIV, when seen from Mahadeo Pokra. A comparison between the telephotograph in the Journal and the enlarged panorama made by me, or my photograph shows conclusively that they are views of one and the same point; possibly, the man who pointed out this peak to me as Gaurisankar was the same man who pointed it out to Dr. Boeck. Though from the parade ground at Katmandu, Gaurisankar (peak XX) is undoubtedly the most prominent peak visible, and from Mahadeo Pokra (about 800 ft. below the summit on the same range is Nagarkot, where the Maharaja has some bungalows which he visits during the hot months), it is an imposing mass but by no means the most striking from Kaulia, seen as it is across a mass of intervening hills, it is rather an insignificant looking peak, and peaks XXII, XXIV, the group containing XXVI and XXVII, and XXVIII, are by far more striking and imposing. Everest as can be seen from the photos both from Kaulia and Mahadeo Pokra, is the least imposing of all and, standing as it does quite apart from, and a long way behind the main range, to call it a peak of the Gaurisankar group is absurd, and there appears to be not the slightest grounds for giving it that name. From no peak on the hills surrounding the Nepal valley would any native select Everest as being the highest in the world, or even as anything like as high as the big masses visible, and it is hopeless to expect to obtain a name for this peak from the inhabitants of the valley when they are content to allow so many masses which are far more conspicuous, to remain nameless.

Appendix No. 1.

Co-ordinates of Snow Peaks used in fixing Kaulia hill station.

Name of Peak.	Latitude.			Longitude.			Height in feet.
	°	′	″	°	′	″	
Peak XXII	28	7	40·97	85	54	43·01	21,840
" XXIV	28	10	25·06	85	49	18·48	22,880
" XXV	28	15	21·52	85	33	35·92	23,750
" XXVII	28	20	43·29	85	7	24·46	23,300
" XXVIII	28	26	2·99	84	41	0·89	25,800
" XXX	28	33	0·29	84	36	10·25	26,660

Mean Values of Angles measured at Kaulia hill station between the Snow Peaks.

Name of Peak.	Horizontal Angle.			Vertical Angle.			
	°	′	″		°	′	″
R. M.	0	0	0		—	—	—
Peak XXII	32	39	7·7	E	3	20	43
„ XXIV	40	10	38·2	E	3	53	46
„ XXV	64	3	11·9	E	4	58	16
„ XXVII	108	5	58·0	E	4	26	39
„ XXVIII	133	51	6·0	E	3	17	14
„ XXX	132	33	27·8	E	2	51	46

Results of Observations for Latitude and Azimuth.

Date 1903.	Latitude. Star.	Latitude N.			Azimuth of Referring Mark. Polaris.			Ursae Minoris.			Mean of Day.		
		°	′	″	°	′	″	°	′	″	°	′	″
Oct. 24th	Polaris	27	48	29·6	93	26	48·0	93	26	36·4	93	26	43·43
	α Gruis			21·3			52·0			37·3			
„ 26th	Polaris			25·3			45·6			44·2			45·77
	γ Gruis			23·8			52·0			41·3			
„ 27th	Polaris			26·9			37·1			49·3			41·75
	α Piscis Aust			27·6			34·1			40·5			
	Means	27°	48′	25·8″	93°	26′	44·8″	93°	26′	42·5″	93°	26′	43·65″

Azimuth of R. M. from h. s.=273° 26′ 43·7″.

Mean Computed Distances and Azimuths.

Object.	Distance. Log feet.	Miles.	Azimuth.		
			°	′	″
To Kaulia h. s. from Peak XXII	5·3678987	44·184	61	4	22
„ „ XXIV	5·3381499	41·259	53	31	38
„ „ XXV	5·2638645	34·772	29	30	28
„ „ XXVII	5·2984811	37·657	345	16	47
„ „ XXVIII	5·4708605	56·005	319	18	0
„ „ XXX	5·5372321	65·253	320	34	41

Resulting Co-ordinates for Kaulia hill station.

Computed from.	Latitude.			Longitude.			Height in feet.
	°	′	″	°	′	″	
Peak XXII	27	48	58·31	85	16	48·78	7,088
„ XXIV			58·87			47·34	7,069
„ XXV			58·31			48·75	7,085
„ XXVII			58·79			47·16	7,033
„ XXVIII			58·39			48·50	7,026
„ XXX			58·82			46·89	7,005
Mean	27°	48′	58·6″	85°	16′	47·9″	7,051

Observed Latitude=27° 48′ 25·8″
Computed „ =27° 48′ 58·6″
∴ O—C = −32″·8

Results of Identification of Snow Peaks.

Name of Peak.	Latitude.	Longitude.	Azimuth.		Height.	
			Computed.	Observed.	Computed.	Observed.
	° ′ ″	° ′ ″	° ′ ″	° ′ ″		
Peak XV	27 59 16·22	86 58 7·09	263 4 51	263 4 14	29,002	28,764
„ XVIII	27 52 50·52	86 31 58·62	266 23 49	266 23 10	21,980	21,870
„ IXX	27 57 51·97	86 22 43·27	261 6 44	261 6 18	23,440	23,386
„ XXI	27 57 28·83	86 9 8·85	259 26 8	259 25 52	19,550	19,501
„ XXIII	28 21 6·74	85 49 21·76	221 49 7	221 49 24	26,290	26,266
„ XXXIII	28 29 23·77	84 13 57·42	126 13 2	126 12 15	22,920	22,845
„ XXXIV	28 32 4·99	84 9 52·78	126 16 48	126 16 51	26,040	25,998
„ XXXV	28 32 11·32	84 7 32·33	125 25 22	125 26 0	24,690	24,665
„ XXXVII	28 29 40·71	83 59 22·12	120 58 40	120 59 20	22 940	22,940
„ XXXVIII	28 29 53·64	83 59 20·56	121 6 10	121 6 41	22,960	22,911
„ XXXIX	28 35 44·31	83 51 46·52	122 10 12	122 10 33	26,492	26,413
„ XL	28 31 5·21	83 50 55·72	119 17 52	119 17 52	23,607	23,539
„ XLVII	28 40 26·10	83 19 7·02	116 44 41	116 44 55	23,539	23,474
„ S 12	28 15 51·0	85 14 10·3	175 3 15	175 5 13	19,130	19,101
„ Bi 7	28 22 45·3	85 6 0·9	164 14 12	164 13 35	23,310	23,180
„ B 484	28 6 14·6	85 56 35·7	243 43 5	243 46 7	19,740	19,893
„ S 31	28 10 10·0	85 43 17·7	227 52 40	227 54 12	...	...
„ T 8 or S 30	28 14 59·1	85 47 32·0	226 14 11	226 14 44	...	...
„ Ma	28 23 27·3	84 49 55·2	145 27 5	145 27 21	...	...
„ S 7	28 19 55·1	85 12 7·2	172 22 49	172 22 5	...	...
„ S 8	28 19 53·8	85 12 22·0	172 46 22	172 45 56	...	...

Note on Captain Wood's identifications.

The "computed" azimuth is the true azimuth of each peak from the point of observation (Kaulia or Mahadeo Pokra), obtained by computation, using the co-ordinates of the point of observation as determined by Captain Wood and those of each peak as previously fixed by triangulation. The "observed" azimuth is that measured by Captain Wood with the theodolite from his point of observation to the peak. Similarly the "computed" height is that of each peak as previously determined by triangulation at the time the peaks were fixed, the "observed" height being that determined by Captain Wood by theodolite from his point of observations. On the agreement of these computed and observed azimuths and heights, the identification of the peaks rests. Absolute agreement is not to be expected, as the observations were taken to the more or less indefinite summits of the peaks which renders it very probable that in many cases Captain Wood did not observe exactly the same spot on each peak which was taken when the peak was originally fixed. In the case of heights no close agreement is to be expected on account of the uncertainty of the effects of refraction at these high altitudes. The agreement of the figures in Captain Wood's tables are quite sufficiently close to enable us to accept the identifications with perfect confidence.

Appendix No. 2.

Co-ordinates of Snow Peaks used in fixing Mahadeo Pokra hill station.

Name of Peak.	Latitude.	Longitude.	Height in feet.
	° ′ ″	° ′ ″	
Peak XXIV	28 10 25·06	85 49 18·48	22,880
„ XXV	28 15 21·52	85 33 35·92	23,750
„ XXVI	28 23 29·89	85 10 12·63	24,300
„ XXVII	28 20 43·29	85 7 24·46	23,300
„ XXVIII	28 26 2·99	84 41 0·89	25,800
„ XXX	28 33 0·29	84 36 10·25	26,660

Mean values of angles measured at Mahadeo Pokra hill station between the Snow Peaks.

Name of Peak.	Horizontal Angle.	Vertical Angle.
	° ′ ″		° ′ ″
R. M.	0 0 0		— — —
Peak XXIV	63 59 33·1	E.	4 25 9
„ XXV	89 42 38·9	E.	4 23 28
„ XXVI	115 50 8·3	E.	3 8 2
„ XXVII	120 10 12·8	E.	3 1 34
„ XXVIII	135 39 29·6	E.	2 16 36
„ XXX	133 59 19·1	E.	2 2 30

Results of observations for Latitude and Azimuth.

Date 1903.	Latitude. Star.	Latitude N.	Azimuth of referring mark. Polaris.	ζ Ursae Minoris.	Mean of a day.
Nov. 7th.	Polaris	27° 40′ 54″·3	89° 25′ 64″·1	89° 25′ 46″·8	89° 25′ 56″·55
	β Gruis	... ... 52·1	... ... 55·2	... ... 60·1	
„ 8th.	Polaris	... ... 57·2	... ... 56·6	... ... 52·2	... ... 56·60
	α Gruis	... ... 52·1	... ... 60·3	... ... 57·3	
	Mean	27 40 53·9	89 25 59·1	89 25 54·1	9 5 56·6

Azimuth of R. M. from h. s. = 269° 25′ 56·6″

Mean computed distances and Asimuths.

Object.	Distance. Log feet.	Miles.	Azimuth.
To Mahadeo Pokra hill station from Peak XXIV.	5·2876466	36·729	25° 33′ 42″
„ „ „ XXV.	5·3117720	38·828	359 43 0
„ „ „ XXVI.	5·4535631	53·518	333 24 58
„ „ „ XXVII.	5·4419195	52·394	329 3 22
„ „ „ XXVIII.	5·5926676	74·137	313 22 3
„ „ „ XXX.	5·0428863	83·224	314 59 39

Resulting co-ordinates for Mahadeo Pokra hill station.

Computed from.	Latitude.	Longitude.	Height in feet.
Peak XXIV.	27° 41′ 31″·80	85° 33′ 47″·56	7,109
„ XXV.	... ... 31·54	... ... 47·20	7,133
„ XXVI.	... ... 31·58	... ... 47·25	7,070
„ XXVII.	... ... 31·29	... ... 46·92	7,091
„ XXVIII.	... .. 31·08	.. ... 46·50	7,072
„ XXX.	... ... 31·53	... ... 47·06	...
Mean	27 41 31·5	85 33 47·1	7,095

Note.—Height of Mahadeo Pokra hill station computed from Peak XXX is 7,099 feet. As this is so discordant it has been rejected.

Observed Latitude = 27° 40′ 53·9″.
Computed „ = 27° 41′ 31·5″.
∴ O.-C. = −37·6″.

Results of Indentification of Snow Peaks.

Name of Peak.	Latitude.	Longitude.	Azimuth. Computed.	Observed.	Height. Computed.	Observed.
Peak XV.	27° 59′ 16″·22	86° 58′ 7″·09	256° 21′ 14″	256° 20′ 40″	29,002	28,929
„ XVII.	27 45 15·54	86 36 58·10	265 57 22	265 56 43	22,820	22,763
„ XVIII.	27 52 50·52	86 31 58·62	257 26 20	257 25 26	21,980	21,933
„ XIX.	27 58 17 82	86 28 33·08	250 46 42	250 45 41	23,560	23,538
„ XX.	27 57 51·97	86 22 43·27	249 13 17	249 13 54	23,440	23,392
„ XXI.	27 57 28·83	86 9 8·85	242 57 16	242 56 38	19,550	19,477
„ XXIII.	28 21 6·74	85 49 21·76	199 11 18	199 10 50	26,290	26,339
„ XXXIII.	28 29 23·77	84 13 57·42	124 22 53	124 21 55	22,920	23,021
„ XXXIV.	28 32 4·99	84 9 52·78	124 31 51	124 31 46	26,040	...
„ XXXV.	28 32 11·32	84 7 32·33	123 51 56	123 52 56	24,690	24,835
„ XXXVII.	28 29 40·71	83 59 22·12	120 16 30	120 17 25	22,940	23,057
„ XXXVIII.	28 29 53·64	83 59 20·56	120 22 46	120 22 26	22,960	23,084
„ XXXIX.	28 35 44·31	83 51 46·52	121 20 52	121 21 2	26,492	26,563
„ XL.	28 31 5·21	83 50 55·72	118 55 31	118 55 33	23,607	23,770
„ XLVII.	28 40 26·10	83 19 7·02	116 48 23	116 47 54	23,539	23,766
„ B 439.	27 57 11·2	86 25 18·2	250 55 17	250 54 45	...	...
„ B 522.	28 16 20·3	85 35 48·9	182 57 19	182 57 12	22,010	22,148
„ B 405.	28 10 36·4	85 51 41·7	208 36 21	208 36 0	21,760	21,755
„ B 484.	28 6 14·6	85 56 35·7	219 15 22	219 14 55	19,740	19,901
„ S 31.	28 10 10·0	85 43 17·7	196 23 35	196 23 11	...	...
Kaulia h. s.	27 48 58·6	85 16 47·9	116 18 54	116 18 28	7,051	7,034

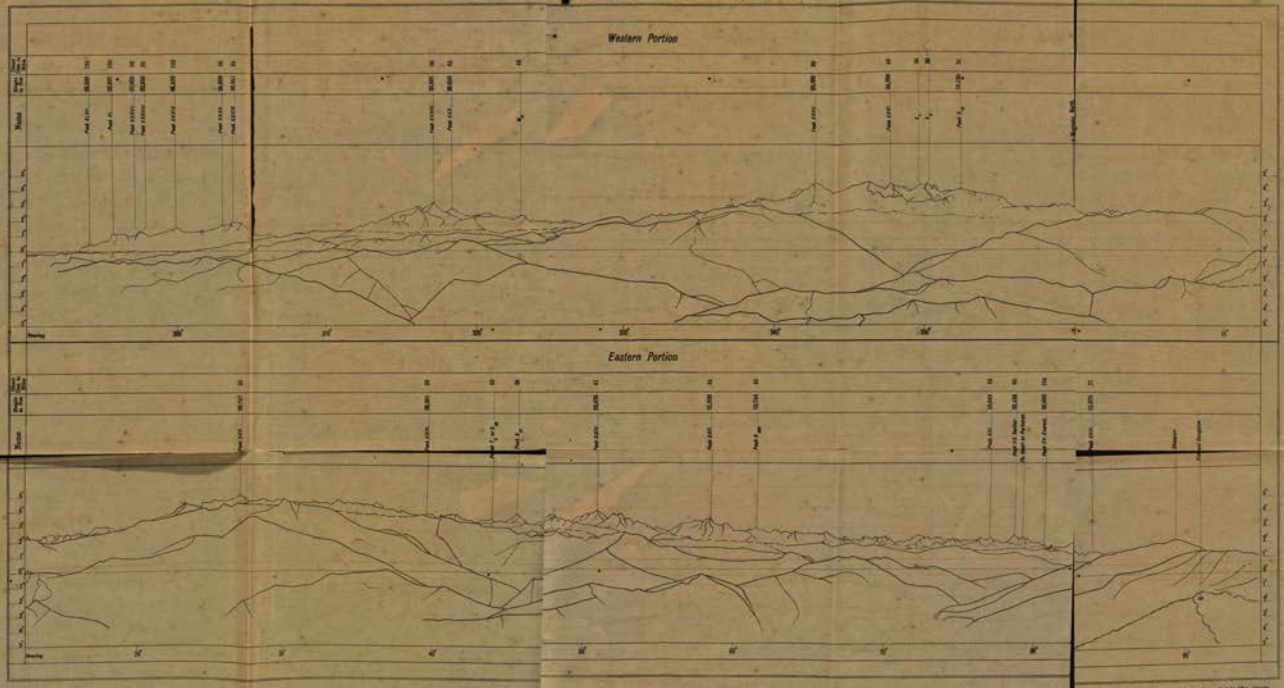
Sketch map of part of Nepal

Scale 1 Inch = 16 Miles.

83°
84°
85°
86°
87°
88°
28°
27°
Marpha
Dhaulagiri
Dhorpatan
Dhor
Dhaulagiri
Dhaulagiri
Dhaulagiri

PANORAMIC PROFILE OF THE HILL RANGES OF NEPAL

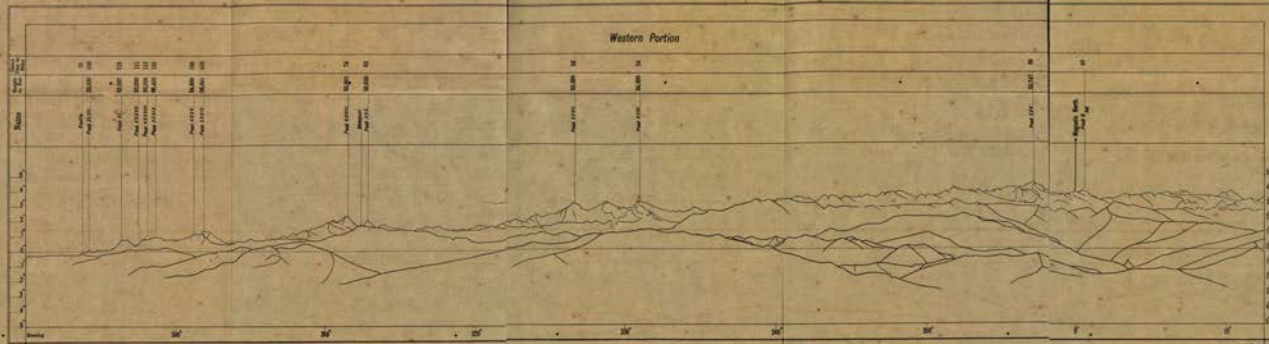
from Kaulia Hill near Katmandu, Lat: 27-49' Long: 85-17' Height 7,051 feet.

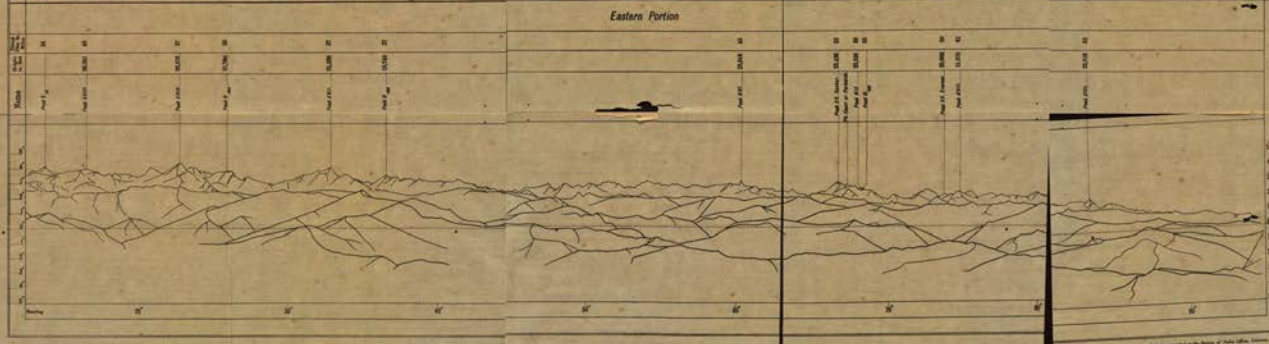


Reg. No. 680-S. 04.

PANORAMIC PROFILE OF THE HILL RANGES OF NEPAL

from Mahadeo Pokra Hill near Katmandu, Lat: 27°-45' Long: 85°-24' Height 7,095 feet.





Reg. No. 679-S. 04.

Report on survey operations with the Tibet Frontier Commission by Captain C. H. D. Ryder, R.E.

On 24th September 1903, I received orders at Bangalore to join the Tibet Frontier Commission at Kam-pa Dzong. Proceeding *viâ* Calcutta where I had to spend a few days collecting instruments and kit, I arrived at Siliguri, the railway base on the 3rd October and marched out the same afternoon to Sevoke, where the Tista leaves the hills. This was not the time of year to see the Tista valley at its best, very hot, raining every day and all day, the march up the valley was far from pleasant. The cart road, now open as far as Gang-tok, was then constantly blocked by landslips and very slippery. After Gang-tok was passed the views of the snows should have been magnificent, but the higher hills were veiled in clouds, all the more pleasant, therefore, was the marked change once the frontier pass, the Kangra La, was crossed; clouds were left behind, and during the two months I stayed at Kam-pa Dzong we had nothing but the finest weather with that wonderful clear atmosphere which every traveller in Tibet has remarked on.

Down the long slope from the Kangra La and over the rolling downs near the village of Giri, the great snowy range gradually opened out, till on reaching Kam-pa Dzong, or at any rate from the hill above it, one continuous line of snows was visible stretching from Cho-mo-lha-ri to Mount Everest, a distance of some 150 miles. We were able to survey from this snowy range northwards to the Arun river—Tsang-po watershed; the Tibetans beyond sending men to watch us, but making no attempt to stop us surveying so long as we did not camp away from the mission post.

As regards the heights of peaks our results were of a negative nature. The highest point on the above named watershed was 20,100 feet; the two "very high snowy mountains" mentioned by Mr. Freshfield on page 362 of the R. G. S. Journal for March 1904 were disappointing, being only 21,200 feet in height. The fine snowy range apparently running north from Everest, but in reality running north, but some 30 miles east of Everest, has its highest summit at an elevation of 22,200 feet. In the photograph by Mr. Hayden (R. G. S. Journal, March 1904) it will be noticed that the northern side (*i.e.*, the right-hand one in the photograph) of Everest has a continuous slope which I estimated at 7,000 feet, and it is extremely unlikely that north of Everest and hidden by the nearer snowy range (on the right edge of the photograph), the peaks could again rise to a height anywhere approaching that of Everest. It is interesting here to note that Everest as viewed from Kam-pa Dzong, does not appear as the highest peak of a group, but as one massive summit standing by itself; nowhere could we hear of any local name for Everest although careful enquiries were made. The height of Kam-pa Dzong itself proved to be 15,200 feet, instead of 13,800 as on previous maps.

Fortunately, just as we had completed all possible surveying from Kam-pa Dzong, it was decided that the mission should retire and cross the Dzelap La into the Chumbi valley. We accordingly hurried across Sikkim, and caught up the main body of the mission and its escort at Chumbi. This valley is disappointing; it has always had a great reputation, but we found it to be only 200 or 300 yards wide, and not very rich. The houses at Rin-chen-gong are good, but this is due to the fact that the Tomos who inhabit the valley having a monopoly of the carrying trade from Phari Dzong down into Sikkim.

A short halt here enabled me to get the lower end of the valley surveyed, and detach Sub-surveyor Dalbir Rai, who followed the valley down to the plains and returned to Gnatong by the adjoining valley, thus completing a most useful piece of work including a hitherto unsurveyed portion of Bhutan.

The mission then moved up to Phari Dzong and over the Tang La (height 15,200 feet), a very easy pass, to Tü-na (height 14,800 feet). Here we spent the winter and except for some work in the Chumbi valley, surveying was nearly at a standstill; the Bhutan snowy range on the east, lower rounded hills on the west, and the Tibetan force at Gu-ru 6 miles north of us, limited our sphere of observation. The cold was intense, and a very unpleasant three months were spent before we again advanced. Numerous cases of pneumonia occurred, mostly fatal. Amongst them were two of my *khalásis*, but Sub-surveyor Hazrat Ali was fortunately one of the few that recovered. Towards the end of March Mr. Hayden, of the Geological Survey and I, with an escort of 20 rifles, made a short excursion across the plain to explore the Ling-shi La, a pass crossing the snowy range into Bhutan. Before, however, reaching this point we were met by a small Tibetan force and requested to return. In view of my knowledge that Colonel Younghusband was very anxious to avoid if possible a collision with the Tibetans, I decided to retire to Tü-na.

General Macdonald and the main force having arrived at Tü-na it was decided to make a preliminary advance to Gu-ru, where the Tibetans were encamped, and establish a post there. Our advance was opposed by the Tibetans who had divided their force, sending half to the east of the Bam Tso on the direct Lha-sa road. A short fight ensued in which the Tibetans suffered heavily. I left a surveyor with the post at Gu-ru, where he was able to do some work, while the main force returned that evening to Tü-na; on the 2nd April Captain Cowie, R.E. joined me, just in time for the advance to Gyang-tse which took place on the 4th April.

The Survey detachment was now constituted as follows:—

Captain C. H. D. Ryder, R.E., in charge.
Captain H. McC. Cowie, R. E.
Surveyor Sher Jang, Khan Bahadur.
Sub-surveyor Dalbir Rai.
Sub-surveyor Hazrat Ali.

Sher Jang remained in the Chumbi valley, the rest of the party accompanied the advance.

We camped on the 4th April at Gu-ru, and then marched round the shore of the Bam Tso to Chalu, and the following day did a short march down the narrow valley along which the stream flows connecting the Bam Tso with the Ka-la Tso. I ascended a point on the range between the two lakes from which a fine view of them was obtained. The Bam Tso has an area of about 25 square miles and the Ka-la Tso of about 15 square miles. Captain Cowie accompanied a mounted infantry patrol as far as Sa-ma-da; they found the village occupied by Tibetans, were heavily fired on, and returned to camp in the evening. Next day the 7th April, we had a level march to Mangtsa, where the open country ends. We could see Sa-ma-da down the narrow valley ahead of us, but the Tibetan force had retired.

There is no outlet to the Ka-la Tso, but there are obvious signs that in ancient times the water flowed out of the lake into the narrow gorge to Gyang-tse and the Tsang-po. About 8 miles from the lake in this direction a small stream rises from what is probably an underground flow from the lake, and flows in a broad and deep bed down the gorge.

From Mang-tsa the force marched to 3 miles short of Kang-mar, while Captain Cowie and I ascended the range to the east to a height of about 18,000 feet to try and get a view ahead; in this we were not successful, still higher hills on the north on both sides of the gorge blocking our view. The Tibetans were reported by the mounted infantry to be in force holding a wall across the valley at Kang-mar, but next day their position consisting of a strongly built wall, (which, however, could have been easily turned,) was found evacuated; next day they were located in a position holding a narrow gorge, known as the Red Idol gorge, with precipitous hills on either side, they were easily turned out of this by a direct attack and a long flanking climb on the part of the Gurkhas. We camped at Sapu that evening and marched on to the Gyang-tse plain the following day. On the 11th April, the Dzong or fort of Gyang-tse was surrendered by the Tibetans who seemed cowed by the defeats they had received; the mission was established in a village on the right bank of the Nyang Chu, where there is a bridge about 1,000 yards from the Dzong.

A force under Colonel Brander consisting of 2 companies 8th Gurkhas, 4 companies 32nd Pioneers, 2 7-prs., 2 machine guns, and 70 mounted infantry were left as escort, while the General and the main force retired to the Chumbi valley, leaving posts at Kang-mar, Ka-la Tso and other places on the line.

We now settled down to a peaceful existence, a bazaar was established outside the post and officers in small parties could wander about the plain shooting.

Captain Cowie and I were then able to start triangulation off a measured base, and with the help of three stations on the hills were able to complete all the work that was possible; but we were not then able to connect this triangulation with Kam-pa Dzong and the Great Trigonometrical peaks, but we fixed some peaks on the Ka-ro La range which afterwards proved invaluable in connecting the Lha-sa triangulation with this work.

Towards the end of the month a report came in that a force of Tibetans had collected on the Ka-ro La, 45 miles from Gyang-tse on the road to Lha-sa. A party, consisting of 50 men of the 32nd Pioneers and 30 mounted infantry under Lieutenant Hodgson, was sent out to verify this report. As this would afford an opportunity of getting in a good addition to our map, I decided to accompany the party with Captain Cowie and Mr. Hayden.

We reached Ra-lung, two long marches from Gyang-tse, on the 29th April, and the following day accompanied by the mounted infantry, rode up to the pass, about 2 miles beyond, where we saw the wall which the Tibetans had built. Lieutenant Hodgson took a few men forward to draw their fire and make them disclose their strength. In this he was successful and withdrawing his men without loss, although some Tibetans concealed on the hills above were rolling rocks down on them, we rode back to Ra-lung. I had intended taking the mounted infantry to Kang-mar in one long day's march, as it was important to have this route reconnoitred, but owing to the presence of the Tibetans in such force on the Ka-ro La, this was not now considered advisable, and we returned to Gyang-tse in two marches, arriving there on the 2nd May.

Colonel Brander then decided to take out a force to turn the Tibetans out of their position on the Ka-ro La, as they were threatening our line of communications. On the 3rd May he accordingly started, Captain Cowie again accompanying, as I hoped he might be able to get the route from Ra-lung to Kang-mar done this time. They attacked the Tibetans on the 6th and drove them out of their position, but owing to our having in the meantime been attacked at Gyang-tse, Captain Cowie had to return with the force.

On the 4th, everything at Gyang-tse seemed peaceable, I had been out for a long day surveying on the hills to the south, and on my return heard of a report, originating from one of the patients in Captain Walton's civil hospital, that we were to be attacked next day. A small mounted infantry patrol went some miles down the Dong-tse road but

found nobody. The Tibetan force, however, was at Dong-tse itself, and leaving when the moon rose about 1 A.M., attacked us just after dawn. Their attack was a complete surprise, but once our men turned out, the Tibetans were easily driven off with heavy loss. If, however, the Tibetans had not given the alarm by shouting and firing their guns, we would have been in a rather awkward position. Another force of theirs had in the meantime occupied the Dzong, from whence they opened a heavy fire which to every one's surprise more than reached our post.

Colonel Brander's force returned on the 9th and as the Tibetans had been hard at work fortifying the Dzong, it was decided that it was impossible for us to attack it with success.

As it was obvious that surveying was out of the question, Captain Cowie and I volunteered for military duty and were appointed Assistant Field Engineer and Field Engineer, respectively, and were fully occupied in re-fortifying the post. The Tibetans never could make up their minds to really attack again, but most nights they used to make an attempt which usually ended in a lot of firing and nothing else. They, however, occupied a house only 450 yards from the post and opened a heavy fire from it. It was gallantly rushed by our men next morning and an outpost, called the Gurkha Post, was established there. The Tibetans also made a regular attempt to invest us by occupying the villages in our rear; they were driven out of several of these and on the 24th May re-inforcements arrived, consisting of 50 of the 32nd Pioneers and 80 Sappers under Captain Sheppard, R.E., and two other R. E. officers.

There being now plenty of R. E. Officers, Captain Cowie and I reverted to our legitimate duties. The Pa-la village which was threatening our post was captured on the 26th May, after a long day's fighting. Captain Cowie left on the 28th May to try and connect the triangulation round Gyang-tse with the Kam-pa Dzong and Sikkim work, but owing to constant cloudy weather he was unable to do so. I spent my time in computations, and in fortifying the Pa-la village, in charge of which I was placed, as I had volunteered to do any R. E. work under Captain Sheppard, R. E.

We thus passed a rather dull existence; the Tibetans made repeated night attacks on the two outposts, but their hearts always failed them; and though at first they were rather exciting and when the Dzong joined in, quite fine pyrotechine displays, but towards the end they became monotonous. During this time Colonel Younghusband left for Chumbi, the post at Kang-mar being attacked as he was passing through, when the Tibetans were easily repulsed.

Towards the end of June the relief force under General Macdonald advanced from Chumbi. The day before reaching we heard that the Tibetans had occupied the Nyening monastery on the road. Colonel Brander, therefore, took out a small force on to the range overlooking the monastery and village from which one had a good view of the fight, which ended in the defeat of the Tibetans in spite of a stubborn resistance. General Macdonald then in a few days captured, first the Tse-chen monastery, which lay on a hill some 4 miles down the valley, and then, though delayed a few days by an insincere attempt on the part of the Tibetans to negotiate, the Dzong was captured on the 6th July, and we were at length free from the continual bombardment which lasted for two months.

Captain Cowie and Surveyor Sher Jang who had come up with the relief force, now rejoined me and on the 14th July we commenced our march to Lha-sa. Owing to the cloudy weather, rendering triangulation impossible, I thought it advisable, in case we could not afterwards connect Lha-sa and Gyang-tse by triangulation, to run a subtense bar traverse, this entailed Captain Cowie and I being on the road all day, starting with the advance guard and getting in in the evening. The weather too was very bad, heavy rain falling almost every day, effectually dispelling the prevailing notion that this part of Tibet is a rainless country.

The Ka-ro La (height 16,200 feet) was crossed on the 18th July, the bulk of the Tibetans holding the position bolting the night before from the wall in the valley, leaving their companions on the hills to their left to escape as best they could. They were easily driven out of their position by the 8th Gurkhas, who established a record in hill fighting at high altitudes, the Tibetan position reaching an elevation of 18,500 feet, and their retreat leading across the face of a glacier.

The next day the force moved to Nan-gar-tse Dzong in sight of the Yam-drok Tso lake. The snow peak marked in former maps in the centre of the promontary round which the Yam-drok Tso makes an almost complete circle, is a myth. No hill there has permanent snow, though as their height is about 17,000 feet, there doubtless is often snow lying there when there is none at Nan-gar-tse Dzong or on the shore of the lake (height 14,350 feet). After a day's halt we marched to Yar-sik where the original outlet of the lake obviously existed. We then marched for two more days along the shores of the lake, which all along this part is never more than 2 or 3 miles wide and very often less.

We crossed the Kam-pa La (height 15,400 feet) on the 24th; an easy ascent from the lake side, but a very long drop down to the Tsang-po. Owing to the low elevation 11,550 feet, and Sarat Chandra Das' description, I thought that the valley would have been well wooded, this, however, was not so the hills were quite bare and no trees grew wild, though round every village there were fine groves. We moved on 6 miles down the river to the place selected for the crossing, where the Tibetans had kindly left a large ferry boat on our side of the river.

The whole force had crossed on the 30th, a very laborious process only marred by the death of Major Bretherton, Chief Supply and Transport Officer, who was drowned by the upsetting of a Berthon boat raft. The valley here is broad and well cultivated, the river running in most places in several broad channels with sandy islands in between. It was about at its highest flood level soon after we had all crossed, with a very fast current deep, and about 140 yards in width.

On the 31st July we moved on, and after a few miles turned up the Kyi Chu, a well cultivated valley with a broad shallow river, resembling the Tsang-po valley on a slightly smaller scale. On the 2nd August we arrived at the To-long Chu, a large affluent of the Kyi Chu, and over which there is quite a good bridge. From here we were rewarded by our first sight of the Potala, the residence of the Dalai Lama, situated on a small isolated hill overlooking Lha-sa. Next day camp was moved to within a mile of the Potala; this was, however, only a temporary camp, and being swampy, another site was selected on drier ground north of the town, the mission being located in a very good house in pretty wooded grounds outside the town.

The weather was not favourable for surveying, rain fell constantly and heavy clouds lay on the surrounding hills, so after measuring a base, and observing a latitude and azimuth we confined ourselves to the survey of the town and suburbs of Lha-sa on the scale of 6 inches to the mile. This took some time, as we were at first not allowed to enter the town itself; but later on, having got in all the somewhat extensive groves, gardens, and summer residences outside the town, we were allowed to march through the streets with an escort. In order to avoid attracting attention, for this portion of the work we did not use a plane-table, but made a compass and pace traverse from one fixed point outside through to another fixed point on the other side. The inhabitants showed some curiosity but no hostility at our proceedings. The height of the plain above sea-level is 11,830 feet.

Captain Cowie left Lha-sa on the 29th August to return to Gyang-tse, to try and secure the connection in the triangulation between that town and the points I had fixed from Kam-pa Dzong. The weather now began to improve and I was able to go out with a small escort, firstly up the valley a day's march from whence I took mounted infantry up to the junction of the Pen-bo Chu with the main valley, just opposite the Ga-den monastery and some 30 miles from Lha-sa and secondly up the Tö-long Chu, a somewhat similar expedition.

Having done these two trips there only remained the Pen-bo La, the pass on the main road leading north and about 10 miles from Lha-sa. This was important for the triangulation, and I was lucky to do all that was necessary in a short spell of fine weather, which just coincided with the five days I spent in camp at the foot of the pass, climbing a hill of 18,000 feet elevation each day. From this range we were able to sketch in carefully the adjoining valley to the north, a broad well cultivated and thickly populated plain; and from three stations I was able to connect on with the peaks of the Ka-ro La range and also to fix many points north and eastwards, including some fine snow peaks south of the Tengri Nur, mentioned by Mr. Littledale, the highest of which was 23,250 feet in height, the highest we ever came across north of the Tsang-po. Two other snow peaks which I fixed are, I believe, those mentioned by M. Bonvalot and christened by him Mount Huc and Mount Gabet, but their heights were disappointing, the highest being 21,500 feet.

The treaty was formally signed at the Potala on the 7th September, and on the 23rd we left on our return march, re-crossing the Tsang-po ten miles above the point where we originally crossed, and then ascending the range between it and the Yam-drok Tso by the Do La, 16,000 feet, a long steep climb from the river. From this pass, the weather being clear, I had a fine view and was able to fix a station by observation to peaks on the Ka-ro La range and to two Bhutan peaks, already fixed from India, as well as to one of my stations on the hills north of Lha-sa. I had gone on ahead of the main force with an escort of 100 Gurkhas under Major Row. Next day we marched along the lake to Yar-sik, and ascended the range again, and observing from two more stations, the required connection between the triangulation done from Gyang-tse and that done at Lha-sa was secured.

At Yar-sik on the 30th September we met Captain Cowie, who though much hampered by the cloudy weather had effected a satisfactory connection between the Gyang-tse triangulation and the Kam-pa Dzong work, we here struck off the main route up the side valley, across a very low, in fact almost inappreciable watershed, and followed down the narrow valley known lower down as the Rong Chu, which flows into the Tsang-po. I have no doubt whatever that this is the old outlet of the Yam-drok Tso which now is land locked. Next day we left the valley, camping near the Nya-dong La, (height 16,000 feet) crossed the pass next day and so on to the plain above Ra-lung. This survey was useful in that it shewed the possibility of turning the Ka-ro La. Captain Cowie then made a round from Ra-lung into the Ni-ru valley down to Gob-shi and so to Gyang-tse, while I caught up the main force. I now made arrangements for Captain Cowie to complete the remaining work between Gyang-tse and Chumbi, on which he writes as follows:—

> "On the 8th October with Sub-surveyor Hazrat Ali and a portion of the survey detachment I left Gyang-tse for Kang-mar, which was reached next day. Commencing a route survey from this village on the 10th, we struck off the

line of communications, marching eastwards through a narrow defile in the bare-rocky hills dividing the waters of the Nyang-Chu and the Ni-ru Chu, as far as the Nilung La, which we crossed the same day, we followed the track which is part of the main road from Kang-mar to Ra-lung *viâ* the Wogya-la. After crossing this pass and descending into the open plain which receives the head waters of the Ni-ru Chu, we turned southwards, heading for the Bam Tso. Passing over the low rolling hills which intervened, we reached the lake on the 14th October, completing the survey of this locality and fixing the position of the Yu Tso, a lake lying at the foot of the snowfields of the big range, culminating further to the south-west in Cho-mo-lha-ri. On the 14th I got into communication with the head-quarter staff which had just reached Ka-la Tso, and, for the purpose of adding to the ½-inch survey of the Kam-bu valley, obtained sanction to strike off the line of communications at Tü-na and crossing a pass some 12 miles west of the Tang La, to follow the course of the Kam-bu Chu, eventually rejoining the force at Chumbi.

Surveyor Sher Jang, who had accompanied the force from Gyang-tse as far as Ka-la Tso, joined me at Cha-lu on the 14th. On the 16th we left Tü-na, taking with us from there, a Tibetan who professed to know the hills to the east of Powhunri, and camped in a small valley below the pass.

On the evening of the 16th snow began to fall and by the 17th, and 18th, a severe blizzard had set in. We left camp on the 17th, in the midst of it, purposing to cross over into the Kham-bu valley, but were unable to reach even the pass. In consequence of mist and the thick driving snow it was impossible to see more than a few yards in any direction: we had no track to guide us and the snow was nowhere less than two feet deep. The difficulties of progressing were great and in addition, we, the guide included, lost our way. Though only a few of the party were frost-bitten, many had begun to suffer from snow blindness. Finding it impossible to proceed, with much trouble, we eventually got back on the 18th, to a point near our camping ground of the 16th. Next day, with over 50 per cent of the party incapable from snow blindness, we crossed the Tang-La and reached Pha-ri in the evening. On the 22nd, I reached Chumbi and reported to the General Officer Commanding (the telegraph line having been broken by the storm), who had sent out a search party for us from Chumbi.

The whole had recovered from snow blindness and the effects of exposure sufficiently to move on the 26th to Chumbi which we left on the 28th, and marching *viâ* the Nathu La and Gang-tok, reached Siliguri on the 5th November."

The survey results of the expedition are as follows:—

Triangulation.—An area of 45,000 square miles was completed connecting Lha-sa with India, all prominent peaks which were visible, with their heights, being fixed.

Topography.—An area of 17,000 square miles was surveyed on the scale of 4 miles to the inch, of which 3,000 square miles in the neighbourhood of the Chumbi valley, Gyang-tse and Lha-sa, were surveyed on the scale of 2 miles to the inch.

Route surveys on the scale of 1 inch to the mile were made of the road to Lha-sa.

Large scale plans were also made of the towns of Gyang-tse and Lha-sa.

Captain H. McC. Cowie, R.E., was of great assistance to me throughout, he is full of energy, and a very good draftsman.

Surveyor Sher Jang, Khan Bahadur, is a most careful and accurate plane-tabler, always turning out excellent work, at my request he was "mentioned in despatches."

Sub-surveyor Dalbir Rai did an excellent piece of work in Bhutan.

Sub-surveyor Hazrat Ali was with me throughout the expedition, he is an honest worker, and has improved greatly in his plane-tabling.

Report on survey operations on the journey from Gyang-tse to Simla viâ Gar-tok by Captain C. H. D. RYDER, R.E.

When the treaty was signed at Lha-sa on the 7th September 1904, it was decided that a party should proceed to Gar-tok to examine the place, as it was one of the trade marts which the Lha-sa Government had decided should be opened in Tibet. It was obvious that this would afford a great opportunity of adding to our geographical knowledge of the country; accordingly with the approval of the Surveyor General, a strong survey party accompanied the expedition. The ostensible object of the journey being a political outcome of the treaty, Captain Rawling of the Somersetshire Light Infantry, the officer deputed to open the trade mart, was placed in general control of the expedition with instructions to conform to my wishes in regard to survey matters. He was assisted by Lieutenant Bailey, 32nd Pioneers, whose knowledge of the Tibetan language proved very useful, the survey party consisting besides myself, of Captain H. Wood, R.E., and Sub-surveyor Ram Singh, R.S. Three military surveyors also accompained us; one of these went sick and had to be sent back from Pin-dzo-ling, and very little use could be made of the other two owing to their limited knowledge of surveying, and to the fact that we were strong enough without them to carry on the work.

In making our arrangements for the journey, two considerations were paramount; firstly that we would be having a race against winter, with a possiblility in the event of our being unable to get over the passes into India before the winter snows fell, the unpleasant prospect would have to be faced of having to winter at Gar-tok or some equally cold and inhospitable spot; secondly it was quite impossible to tell whether and to what extent, the Tibetans would assist us. Fighting had only lately ceased, the treaty had been signed barely a month previously, and there had been no opportunity of seeing whether the Tibetans would adhere to the treaty when our troops were withdrawn to India.

Our time for preparation was very short, every day's delay increasing the probability of our being snowed up. Captain Wood and Lieutenant Bailey arrived at Gyang-tse, which was to be our starting point, on the 30th September, while Captain Rawling and I only reached the same place on the 6th and 5th October, respectively.

Our transport we organised as follows:—Twenty-six baggage ponies to give us a nucleus of our own, should the Tibetans make difficulties about providing us with animals; 17 riding ponies, it being important that, in view of long and continuous marching at a high elevation, as many men as possible should be mounted; 100 yaks were lent to us from one of the Transport Yak Corps to take us to Shi-ga-tse, but not to go beyond that town. From there onwards, however, the Tibetans invariably and without any demur provided us with whatever transport we required. Ponies, donkeys, mules, yaks and coolies at various times carried our baggage, and although it was difficult to supervise so large and mixed a caravan, no single article was lost during the whole time the journey lasted.

We took two months' supplies for all our men, with two months' extra of such things as ghi, goor, etc., which could not be obtained *en route*; while for the officers' mess we took four months stores. Meat we could rely on obtaining in abundance, and *tsamba* or parched barley flour, as long as we came across villages.

Our party was finally organised and ready to start on the 9th October as follows:—

Captain C. G. Rawling, Somersetshire Light Infantry.
Captain C. H. D. Ryder, R.E., Survey of India.
Captain H. Wood, R.E., do. do.
Lieut. F. M. Bailey, 32nd Pioneers.
Sub-surveyor Ram Singh, R.S.
Hospital Assistant Hira Singh.
3 Military surveyors.
5 Sepoys of the 8th Gurkha Rifles.
5 Survey *khalāsis*.
7 Pony drivers.
2 Hindustani servants.
2 Tibetan servants.

Mahomed Isa, a Ladakhi, who acted as caravan leader, and last but not least, a very small Lhasa Blenheim spaniel who followed our fortunes throughout.

In order to have the advantage of the company of Captain O'Connor, who was remaining as trade agent at Gyang-tse, and who with two other officers was making a trip to Shi-ga-tse, we postponed our departure till the 10th.

Our first day's march took us to Dong-tse, the late head-quarters and supply depôt of the Tibetan army, which had attacked the misson and its escort for two long months at Gyang-tse. but here, like everywhere else, we were cordially received, mainly I fancy owing to our being accompanied by a Lhā-sa official who had been deputed to escort us to Gar-tok, and also to our being supplied with a very strongly worded permit signed with the seals of the Lha-sa Government and of the three great Lha-sa monasteries, and directing all officials along the route to render every assistances.

Three more marches, following the valley of the Nyang-Chu, which is one of the richest and most prosperous valleys of Tibet, landed us at Shi-ga-tse on the 14th October. Here we spent several busy days with an army of tailors making warm clothing for ourselves and our men, lining all coats with lambskins, making fur caps and gloves, etc., till finally when fitted out we all presented an appearance akin to Arctic explorers. Our stay at Shi-ga-tse was not, however, all work. We paid a most interesting visit to the great Tra-shi Lhun-po monastery, where the monks received us most cordially, shewing us all over the place, and finally giving us refreshments of tea, cakes and dried fruits. This monastery is said to contain 4,000 monks, and although not so large as, is richer than, the great Lha-sa monasteries. The bulk of the buildings, the residences of the monks, were of the usual type, narrow paved roads with high houses on each side, dirty and not picturesque, but we all enjoyed the sight of the tombs of the five previous Tra-shi Lamas each a separate building with its golden roof, and highly ornamented interior, fitted with a wealth of turquoises, gold bowls, and rare old jade and cloisonné, the effect being somewhat marred by a foreground of small vessels holding lighted tapers, fed by very evil smelling butter. Bogle's description of his visit is very picturesque and accurate, the number of tombs has now, however, increased from three, as seen by him, to five as seen by us.

We were fortunate also in being received by the Tra-shi Lama, who, after holding an almost co-equal position to the Dalai Lama has now by the deposition of the latter, become the most important ecclesiastic in Tibet. He was living in his summer residence, a house outside the town to which, with Captain O'Connor as Political officer at our head, we pro-

ceeded. A little hitch occurred at the gateway, as an arch scoundrel Colonel Ma, who had been the Chinese official at Gyang-tse, when we were attacked, and had never given us warning nor even tried to protect the servants and property of his colleague Captain Parr, was also paying a visit. Captain O'Connor refused to enter the house while this individual was in it, and the latter had to be smuggled out by some back door; we were then shown up some steps and along dark passages till we arrived at the reception room, at the far end of which we could see the Tra-shi Lama seated cross-legged on cushions on a raised platform. He received us each with a bow and a smile which we returned and were shown to seats on one side of the room while the other side was filled with Tibetan officials and monks in either the ordinary maroon coloured clothes usually worn by monks, or in the yellow silk of the higher temporal officers. Tea, undrinkable as usual, was handed round, but on this occasion it had a certain glamour attached, due to its being served in enormous teapots of gold and silver. Dishes laden with sweetmeats and dried fruits were also brought in, and soon hurriedly removed and handed over to our followers.

While Captain O'Connor was exchanging civilities with the Tra-shi Lama we had time to think of the sudden change from a few months before, when the Tibetans, amongst whom was a strong contingent from this very place Shi-ga-tse, were attacking us at Gyang-tse, to the present moment, when we, a few unarmed officers were sitting in amity with our quondam enemies. The Tra-shi Lama himself is an interesting personality, sixth holder of the office, his face is one that would not pass unnoticed anywhere, still less in Tibet. He has clear cut features, high cheekbones, and a pale complexion; his quiet dignified manner made a lasting impression on us. His age is only about 23, and he seemed generally beloved and revered. During the whole of our visit a slight and pleasant smile never left his face. After silk scarves had been presented to us and our Tibetan followers had been blessed, we left, with the feeling, due partly to the personality of the Lama himself, partly to the room with its dim light, that we had been assisting at some religious ceremony.

We had commenced our survey at Dong-tse one march from Gyang-tse and as we wished to keep up triangulation, Captain Wood and I left Shi-ga-tse on the 17th October to do two short marches, the rest of the party leaving a day later and doing the two marches in one. Owing to bad weather, which gave us some rain and covered the surrounding hills with snow, we were unable to reach our hill, so decided to halt a day at Kang-jen Gom-pa, a most delightful camp in a grove of trees. This was the same storm which entailed such hardships on our force returning to India in the neighbourhood of Pha-ri Dzong; fortunately for us we were here at the lowest point of our journey, the height of Shi-ga-tse being 12,570 feet, and escaped with only slight inconvenience. By visiting three hills, one of which was over 18,500 feet elevation, and from two of which we had fine views of Mount Everest, Captain Wood was enabled to carry on the triangulation under very adverse circumstances. To climb one of these hills is itself a hard piece of work, to observe at the top in a bitter wind is one of the most physically painful operations I have ever experienced, and to do this in combination with a day's march, leads to a very long and hard day's work. Captain Wood carried this on for days and months with hardly any intermission, a feat which could only have been accomplished by an officer of his energy and determination.

Until we reached Pin-dzo-ling on the 22nd October the river had been a few miles to the north of our route, but from thence we followed the river more closely. Two more marches and we were at Lha-tse Dzong, a fort on a small rocky hill, very similar to those at Shi-ga-tse and Gyang-tse, surrounded on one side by the river, and on the others by a fair sized monastery and small town. The valley here widens out into a plain, cultivated in parts, barren elsewhere. At Lha-tse Dzong, we halted a day, which enabled Captain Wood and me to ascend a hill a few miles east of the town overlooking a broad bare valley which leads to the very famous Sa-kya monastery. We regretted that want of time, and the consideration that it was not advisable to divide into two parties until we had thoroughly tested the friendly disposition of the Tibetans, had prevented us from paying a visit to this monastery.

From Lha-tse however, the Tibetans having shewn no desire but to assist us in every way, we decided to separate; while Captain Wood and Lieutenant Bailey followed the main route which here crosses and leaves the river, Captain Rawling and I stuck to a route reported to lead along the south bank, as I did not wish, if possible, to omit any portion of the river from our survey.

Accordingly, on the 26th we parted company, camping that night on opposite sides of the valley which now closed in, we kept to the river the following day, but on the 28th we had to leave it and for two marches followed up a side stream, the Chi Chu, running parallel to and only two or three miles distant from the Tsang-po, which we again rejoined on the 30th. On the 1st November, we could see that the river flowed between rocky hills with snow peaks on either side, compelling us to leave it. Making a wide detour to the south we marched up a side nullah, camping in bitter cold at nearly 16,000 feet, and crossing the Kūra La, a very desolate pass, next day at an elevation of 17,900 feet, marching across the head of a plain, which forms the head waters of the Chi Chu, previously mentioned, we passed over an almost imperceptible watershed down a narrow stony valley to the village of Ka-jū. We had a magnificent view from a hill a few hundred feet above the pass of the main Himalayan range. Mount Everest stood up towering above the rest of the range in its neighbourhood, in one isolated peak a continuous drop of some 8,000 feet separating it from the rest of the range east and west of it. The village of Ka-jū (14,800 feet) lies

on the edge of the Su-tso-tang plain, which takes its name from an old ruined fort on a small eminence in its centre. It is here about five miles wide and we could see it trending away southwards and joining the Dingri maidan which lies north of Mount Everest. A day's halt here enabled me to cross this plain, from the hills on the western side of which I obtained an uninterrupted view of Mount Everest, no hills intervening. I was thus able to satisfactorily establish the fact, which I had suspected a year before at Kampa Dzong, that no peaks anywhere approaching the height of Everest exist to the north of it or anywhere in its neighbourhood; it stands alone in its magnificent solitude and is entirely disconnected from the mass to the west, of which peak XX (Gaurisankar) is the best known point, on the south-east of Everest but separated from it by a low gap lies Peak XIII (Makalu). We were here in the valley of the western branch of the Arun or Kosi river, but recrossing the watershed next day by the Sheru La 17,600 feet, we once more reached the banks of the Tsang-po on the 5th November. The scenery was now changing, trees we had said goodbye to some marches back, our last cultivation we passed that day, while the hills were becoming more open and the plains abounded in sand dunes. Brushwood was in places available for fuel, but we preferred argol or dried yak dung as it gave greater heat, and, if the fire was carefully looked after, less smoke. During the whole of this portion of the river journey, we had seen no four-footed game other than numerous hares and a few gazelle on the Su-tso-tang plain, but birds we saw and shot numbers of; Tibetan partridge, ram chikor, and Tibetan sand grouse giving us a welcome change in our otherwise monotonous fare of mutton.

On the 6th we crossed to the north bank of the river with the utmost difficulty, a crazy looking punt manned by lamas took us across in detachments, but owing to the masses of floating ice whirled down the river by the rapid current, the punt was repeatedly forced back, and only reached the opposite shore after floating down some 400 yards; the operation of hauling the boat up again to its original starting point against the ice being very hard work. On the 9th we arrived at Sa-ka Dzong a small village, and found that Captain Wood's party had reached there the day previous. We gave ourselves another day's halt here as there was a good deal of surveying to be done in the neighbourhood.

Captain Wood writes as follows regarding his journey:—

"Leaving Lha-tse on the 26th October we crossed the Tsang-po about half a mile below the town. A couple of boats had been collected by the Tibetans for ferrying across our kit and transport, but the process was very much shortened by the discovery of a ford about ½ mile up stream, by which the ponies were able to cross. After keeping to the north bank for about 10 miles, we turned up a side nullah, and camped at Sang-ge-lung village; following this nullah next day for a short distance, we crossed by an easy pass into a country, the drainage of which led into a succession of small lakes, whose surfaces were covered with geese and duck. On the largest of these the Ngap-ring Tso, a ta-sam or stage house is situated, which place we reached on the 27th, and hearing that no grain would be procurable until we reached Barkha on the Manasarowar lake, we bought all we could procure, but even this would only give our ponies a couple of pounds daily. The next day we passed Ralung the last place we saw cultivation. Every day now found us at a higher altitude as we were marching more or less along the watershed between the Tsang-po and its large tributary the Ra-ga Tsang-po. The valley of this latter stream is narrow, running almost due east and west, parallel to and about 30 miles to the north of the main river. Into this distance is crammed a tangled mass of hills whose crests average about 18,500 feet, with several peaks of about 22,000 feet covered with permanent snow. This part of our march was exceptionally unpleasant, as the wind on the hills never dropped by day below hurricane force, and camping at elevations up to 16,100 feet, the change in temperature from the comparatively warm valley of the Tsang-po, was most noticeable. The hills clothed with a coarse grass on their lower slopes, but quite bare above 17,000 feet, were as a rule easy to climb, and from the summits lovely views of the Himalayas were obtained. Makalu and Everest, both standing out as great isolated peaks, being particularly imposing. The ta-sams at which every four or five days we changed our yaks for fresh ones, were the only signs of habitations we encountered, and these as a rule consisted of tents with a mud hut or two. The marches were all long, and wearisome in their monotony, and owing to the narrowness of the valley, Ram Singh and I had to climb to the crests of the range every day, to carry on the survey, seldom getting into camp before sunset, and on one or two occasions not arriving before nine or ten at night. On the 5th November, we crossed the Ku La (16,700 feet), situated at the head waters of the Ra-ga Tsang-po, and by a steep descent dropped into the valley of a small stream draining into the Tsang-po. At that night's camp we received letters from Captain Ryder saying that he would arrive at Sa-Ka Dzong on the 9th. Passing under the snowy range of Cho-ur Dzong, whose peaks range up to 21,000 feet, we reached Sa-Ka Dzong on the 7th November".

During our halt at Sa-Ka Dzong, Captain Wood ascended a high peak to the north (19,300 feet), from which we had a fine view north, up the valley of the Charta Tsang-po, a tributary of the main river.

Sa-Ka Dzong (height 15,150 feet) has only a dozen or so houses, very dirty, the neighbourhood being like that of every Tibetan village, a dust and refuse heap. We left on the 11th November, again in two parties; this time Lieutenant Bailey accompanied me back to the river, while Captains Rawling and Wood followed the main route. That day

we forded the Char-ta Tsang-po, a fair sized affluent of the main river, and crossing some low hills, reached the Tsang-po on the 12th, which we crossed late on the same evening, it being necessary to do so then, as from my previous experience, I knew that the river would be nearly impassible in the morning from floating ice. We crossed in a small skin boat, our animals fording higher up. For several days we marched up stream in a broad valley covered with low sand dunes and stones, with a very small quantity of poor looking grass on which, however, kyang and gazelle seemed to thrive. The track followed by the Pandit Nain Singh, as he marched up from Nepal to Tra-dom in 1865, joined in on our left, but in these plains in Tibet, it is difficult to find any signs of a path, as every caravan meanders over the plain without keeping to any defined track.

We recrossed the river on the 16th, but now it was completely frozen over; a good track was made for the animals by throwing some earth down on the ice. That evening we reached Tra-dom, where we found the rest of the party had arrived on the 14th. The weather had taken a turn for the worse; low temperatures at night with cold winds in the day were the rule, but if the days were sunny, a little walking would soon make us warm; when the days were cloudy, however, there was nothing to counteract the cold, and a march was a most miserable performance.

Captain Wood writes:—"On leaving Sa-Ka Dzong our party kept down the valley till we reached the Char-ta Tsang-po, which we found no difficulty in crossing. The stream was at that time some 100 feet in width with a depth of two feet flowing in one channel, having just left a very deep narrow valley to emerge into a plain of about 3 miles in width. Striking up a small side nullah we followed it for 5 miles and camped at the foot of the La-lung La. On this pass we first saw signs of ovis ammon, and from the information we received, this appears to be the eastern limit of their habitat along the road we had traversed. The road for the next three days, if it can be called a road, was the worst we met with, and consisted of large broken rocks set in deep sand; and to make us even more uncomfortable, the weather changed to snow accompanied as usual by a howling gale of wind. Inhospitable as Tra-dom appeared to us when we first described it, we hurried on as fast as our ponies would take us, to get within the shelter of its single stone house, where we might warm our frozen limbs over a yak dung fire, and pity the remainder of our party who had still another two days to endure before they could hope to join us."

Tra-dom did not tempt us to halt, it is a desolate spot, with a small monastery on the hill above, inhabited by only 3 or 4 monks; but from the hills to the north, we had a fine view of a snowy range reaching an elevation of 23,200 feet. We accordingly left the next day, and marching across the plain all day, camped amongst the hills on the far side. This plain is full of small ponds lying among sand dunes, and there was an unpleasant tributary or two to cross, the water frozen at the edge for four or five yards, then a drop of 3 feet into icy cold water full of floating ice, ending with a scramble out on the other side on to ice again. We now followed the river valley for a week or so, always in the same large plains, until we could see the watershed range ahead of us from the valleys of which innumerable streams issue to form the Tsang-po, the largest coming from a snowy range to the south-west. After enjoying some days of bright sunshine, the weather again took a turn for the worse, and we crossed the Ma-yum La, (height 16,900 feet) on the 26th November with a foot or two of snow on the ground. We had now finished with the Tsang-po, having surveyed it from Shi-ga-tse to its source. Our next point of interest was to be the lake region ahead of us. The day after crossing the Ma-yum La we camped on the northern shore of the Gün-chu Tso, a lake 11 miles long by 2 or 3 miles broad, with an area of 22 square miles, completely frozen over, and having no outlet at all. Several ovis Hodgsonii (ammon) had been shot before reaching the Ma-yum La, and we now came on large herds of Tibetan antelope, of which we each shot several, and could have shot many more if we had wished, as they were very tame. Crossing several low passes and generally undulating ground we came in sight of the Manasarowar lake (Tibetan Tso Mo-bang) on the 30th November. The lake is neither impressive nor beautiful, like say, the Yam-drok Tso passed on the way to Lha-sa. It was not frozen over, except for 100 yards or so round the edge. The water was fresh, and our Surveyor Ram Singh, on account of its sanctity, bottled some and carried it back with him to his home in Dehra Dún. Skirting the lake, we rode across the low hills which close in on the western side, to look for the outlet, which Moorcroft had not been able to find, which Strachey had found, and which Mr. Savage Landor had claimed to have discovered did not exist. We struck the channel a mile below the outlet, a small stream only partly frozen over, this we followed up and found that it did not flow from the lake but from a hot spring, at which we found and shot some mallard. We then followed up the dry nullah to the lake, and proved that Strachey was, as was to be expected quite correct. No water was flowing at this time of year, but the local Tibetans all agreed that for 4 months in each year there was a flow during the rainy season and the melting of the snows, *i.e.*, about from June to September. As a rise of about 2 feet in the level of the lake would cause water to flow down the channel, this appears quite worthy of belief. The length of the channel between the two lakes is about 3 miles That day, the 2nd December, we reached a Tibetan stage house, and next day had a long days ride to try and discover an outlet for the second lake, the Rakas Tal or Tibetan La-gang-Tso. This lake is very dissimilar to Manasarowar in shape, and was entirely frozen over. The latter is about the same width 12 miles north and south as it is east and west, with

an area of 110 square miles ; the former is a long narrow lake running north and south, some 16 miles long by 3 or 4 miles wide, with an area of about 55 square miles.

It is the sacred character of the Manasarowar lake rather than its size which has made it well known ; its height above sea-level is 14,900 feet. We found an old stream bed issuing from the Rakas Tal, but every Tibetan we asked told the same story, that no water ever flowed along it now, but in days gone by, one man saying before the Sikh War, water did flow out of the lake and down this channel. We followed it down for some 6 miles along the plain, and could find none of the ordinary signs of water flowing down it, until we reached some low hills ; here, evidently from the lie of the sand, water flowed at some time of the year and away from the lake. The lakes being now entirely disconnected at all times of the year from the Sutlej, the sources of that river must lie in the hills on either side of the valley and west of the lake region.

The Kailas snow peak was very prominent on the hills to the north, 21,800 feet in height. The strata forming the mountain are horizontal, which gives it a peculiar appearance ; from the side we saw it, the top was quite inaccessible. There are several monasteries on the path which pilgrims follow in circumambulating the mountain. A very fine snow mass culminating in a peak over 25,000 in height, Me-mo or Gur-la Mandhata, lies to the south of the Manasarowar lake. A low watershed south-west of the lake leads to Purang or Taklakot.

Keeping to the north side of the broad open valley in which the Sutlej flows we arrived at another stage, Men-ze or Missar on 5th December. Here we divided sending our heavy baggage down with Ram Singh, as I wanted him to continue the survey of the Sutlej valley, while we went into Gar-tok. We were pleasantly surprised to find the Jer-ko La, the pass on the Sutlej-Indus watershed low and easy (height 16,200), and without difficulty reached Gar-tok (height 15,100 feet) on the 9th. This is the summer residence, Gar-yarsa. The two Gar-pons, the joint governors of western Tibet were residing at Ger-gunsa, the winter residence, some 30 miles down the valley, but had come up to receive us.

We only halted one day at Gar-tok, in that time we had seen more than enough of it ; we were unanimous in looking on it as one of the most dreary inhabited places we had struck in our journey ; a long broad plain, absolutely bare, with a dozen wretched hovels in the middle, constitutes, at this time of year, what is in summer the chief trading centre of western Tibet ; but in the summer, traders are said to collect in large numbers, living in tents. The wind howled round the hut we were in continuously, and the weather looking threatening, we were not anxious to stay a minute longer than was necessary for Captain Rawling to settle up trade questions with the Gar-pons. Having now accomplished the main object of our journey, it only remained for us to get back into India as soon as possible. Fortune had favoured us so far but we had some high passes to cross. The first of these was the Ayi La, height 18,700 feet ; two marches took us to the top of the pass, encountering a blizzard the second day. That evening we saw the only herd of wild yak we had come across in our journey. Crossing the pass next day was no easy matter, the ascent was gradual, but there was 2 feet of snow on the ground and a bitterly cold wind was blowing. It was with the utmost difficulty that, under some shelter from a rock, I took boiling point observations, and with a sigh of relief hurried down the other side. One of our chief obstacles was surmounted. It began snowing on the pass that evening so we had only just crossed in the nick of time, at Dun-kar (14,100 feet) where we camped that night we met cultivation for the first time, and it was a pleasant feeling, we were gradually coming to the end of high altitudes.

From here Captain Rawling and Lieutenant Bailey next day marched to Totling (Tibetan Tü-ling) on the Sutlej, where they met Ram Sing's party. Captain Wood and I halted a day at Dun-kar and marched next day to Ti-bu, where the whole party was once more united. We were now in the most intricate country I have ever seen, it must resemble the loess formation of Western China. The bottom of every nullah was some hundreds of feet below the general level of the valley, with their edges so cut and worn into fantastic shapes that it was difficult to believe that one was not looking on the ruins of old castles. There are also innumerable caves in which the inhabitants live.

On the 16th December at Kyi-ni-puk, we met Thakur Jai Chand who had been sent up as our trade agent at Gar-tok ; he brought with him some very welcome newspapers. I must own we none of us envied him his job for the winter.

Each day's march now consisted of climbing up out of a deep nullah and down again into the next. We crossed the Shi-ring La 16,400 feet on the 21st in deep snow with great difficulty, the descent on the western side being very bad going. Next day we camped at Tyak on the Sutlej, which had been flowing to the left of our route only a few miles distant, but invisible to us owing to its being at the bottom of a deep gorge. On the 23rd we marched to Shipki, crossing the river on the ice at an elevation of 9,300 feet. On Christmas Eve we surmounted our last obstacle, the Shipki La on the frontier, a climb of 5,000 feet mostly in snow and a drop of 6,000 feet on the other side, camping at Khab in British territory. From here we had 18 marches into Simla, finding bungalows at every stage, on and after 28th December, finally arriving at Simla on the 11th January.

I am indebted to Captain Rawling for the unfailing readiness with which he fell in with my proposals regarding the survey work, and for the excellent transport arrangements he made *en route*. Lieutenant Bailey's knowledge of the language was of the greatest assistance in obtaining for us the correct spelling of names and other information.

Captain Wood, as I have already mentioned, carried out the triangulation in a wonderful way. No one who has not experienced it knows the determination necessary to stay on a hill top in the bitter cold, and the pain involved in touching the screws of a theodolite.

Sub-surveyor Ram Singh is a first rate trans-frontier surveyor, and added one more to the list of expeditions on which he has done excellent work.

Hospital Assistant Hira Singh, not only doctored our party and brought us through without the loss of a man, but created an excellent effect by the care and patience he displayed in attending to the many Tibetans who came in to be treated.

The area surveyed with the plane-table comes to about 40,000 square miles, comprising the valley of the Tsang-po from Shi-ga-tse to its source, and the Manasarowar lake region, the doubtful points connected with which have been the subject of much discussion were satisfactorily decided. We completed the survey of the Sutlej river from its source to where it enters British territory, as well as the source of the Gar-tok branch of the Indus.

The triangulation, which is still under computation, was invaluable in correcting the plane-table work, and determining heights.

An account of the Scientific work of the Survey of India, and a comparison of its progress with that of Foreign Surveys by Lieutenant-Colonel S. G. Burrard, F. R. S., R.E.

The scientific work of the Survey of India consists of—

Principal Triangulation
Levelling Operations
Astronomical Operations
Pendulum Operations
Tidal Operations
Magnetic Survey
Solar Photography.

I beg that I may show in a few brief notes the uses and aims of the scientific work of the survey, but before doing so I wish to premise that no distinction can properly be drawn between scientific and practical work. Many operations conducted on scientific principles have immediate practical uses: they may in fact be likened to the exploitation of visible outcrops of coal. Others are more experimental, and may be likened to borings for invisible coal, believed to exist at certain depths. Others again are speculative, and may be likened to deeper borings, made to ascertain the strata in the crust, with the hope, that something valuable, perhaps coal or iron or gold, may turn up. But whether such operations are practical or experimental or speculative, they all have the same twofold purpose, *viz.*, the acquisition of information, and the rendering of that information useful. Almost all the the scientific operations of the Survey of India will be found to fall into the first category, and to possess immediate practical uses.

Before I enter into the details of the different scientific operations of the Survey of India, I may perhaps be allowed to refer briefly to the general question of the connection between science and surveys in modern times.

The primary object of a national survey is the making of maps, and all operations are subordinated to that end. It is for topographical purposes that a national survey measures its allotted portion of the earth's surface. If, however, these measurements be subsequently combined with astronomical determinations, the size and shape of the earth can be deduced, and a knowledge of this size and shape is essential to astronomers, geographers, geologists and meteorologists, all of whom look to surveys for information.

The great accuracy of modern astronomical observations for stellar and lunar parallax, and the difficulty, which mathematicians still experience in predicting exactly the places of the moon and the planets, are constantly necessitating more refined determinations of the figure of the earth, and astronomy is continually bringing pressure to bear upon surveys to lend her their aid,—for her celestial measurements must always emanate from a terrestrial base.

Man's first conception of the earth's figure was a plane: Greek philosophers thought it a sphere: Sir Isaac Newton showed that it must be a spheroid. Colonel Clarke, of the Ordnance Survey, contended that it was a triaxial ellipsoid. Modern Geodesy, after encountering great difficulties in testing in the field the theories of Newton and Clarke, has pronounced it a geoid. Astronomy now wishes us to tell her the dimensions of this geoid, and its departures from a spheroid.*

In the days of Everest the figure of the earth was deduced from linear measurements, and the Great Arc of India was the only series of triangulation in India originally designed for a figural determination: all our other triangulation was intended and executed for the purpose of controlling topography. In 1858, Colonel Clarke showed that the figure and dimensions of the earth could be better deduced from measured areas than from measured arcs, and the whole triangulation of India became at once available for the discussion, provided it were subjected to astronomical tests.

A small portion only, however, of the earth's surface has so far been surveyed; and our present idea of the dimensions of our planet has been derived from wide generalisations. The total area of land and sea amounts to nearly 200 millions of square miles: the areas that have been surveyed do not aggregate 6 millions of square miles.

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* The geoid is the figure enclosed by the surface of the sea: this surface is that of a spheroid disfigured by protuberances and hollows.

The determination of the figure, and of the dimensions and of the specific gravity of the geoid is now in the hands of an International Geodetic Association, at whose conferences Professor George Darwin, F. R. S., represents Great Britain: India's co-operation is the more valued by the association, because she alone of the civilized nations possesses an equatorial area, and because she includes within her dominions the highest points of the earth's surface.

The amount of money spent annually by Europe and America on astronomical observations, runs into many millions sterling: humanity is striving to discover new facts concerning the myriads of distant bodies moving in space. As her development progresses, she grows ever more desirous too of investigating the one celestial body, which she can touch, and on which she finds herself travelling amongst the stars.

The difficulties, however, of studying even our own earth are great, because we are tied to its surface: our meteorologists cannot ascend into the atmosphere, our geologists cannot penetrate into the interior. We have learnt that the globe of rock, which constitutes our inter-planetary home, is the source of two great forces, gravity and magnetism; and a knowledge of the actions of these forces has become of importance to almost every branch of science. Their actions we have discovered are strangely dissimilar, and vary both with time and place.

The civilized nations are now making gravimetric and magnetic surveys of the earth, and are measuring the intensities, the directions and the pulsations of the terrestrial forces. India has been asked to bear her share, and to carry these operations over her own fraction of land-surface.

THE PRINCIPAL TRIANGULATION OF INDIA.

Its Accuracy.

The principal triangulation of India has been repeatedly attacked on the grounds that it is too accurate and too scientific for practical purposes. In 1800, in 1824, in 1850 and in 1886, attacks were made, but the Government after enquiry ordered its continuance. The present seems a good opportunity to take stock, to see what the triangulation has done for us and what it has cost us, and to consider by the light of modern requirements its accuracy and its errors.

The operations of a survey may be conveniently divided into, (1) the controlling framework, (2) the artistic superstructure. In discussing errors and accuracy it is advisable to keep these two divisions distinct, for whilst the controlling framework has to be guarded against cumulative errors, the artistic superstructure is only liable to accidental or local errors. The framework is constructed as follows:—

Foundation	Principal Triangulation.
Plinth	Secondary Triangulation.
Walls	Tertiary Triangulation and Traversing.

Points fixed by tertiary triangulation or traverse should be sufficiently numerous to save the topographer from cumulative errors. Tertiary triangulation and traverses themselves, are liable only to accumulate errors over the short distances between secondary stations. In secondary triangulation the accumulation of error is confined to the distance which separates stations of the principal triangulation. In all survey operations, therefore, *after* the principal triangulation the accumulation of error is arrested: but what arrests the accumulation of error in the principal triangulation itself? The answer is that observations of a principal triangulation must be sufficiently accurate in themselves to avoid *embarrassing accumulations of error.*

We have been accustomed to state the error of triangulation in so many inches or so many feet per mile, and this custom has led laymen to believe, that the errors of principal triangulation are dispersed throughout its length. But the statement that an error has been found of 1 foot in a mile, is merely made to enable the merit of the triangulation to be gauged: in a length of 500 miles an error generated of a foot a mile is not dispersed, but is accumulated at the terminal. It follows, therefore, that the *requisite* precision of a principal triangulation must vary with the *distance* to be triangulated.*

The following table shows the relative degrees of accuracy in the triangulations of different countries: the precision and length of the triangulation of Great Britain have been taken as the units.

Country.	Precision of triangulation.†	Length of triangulation.	Ratio of precision to length.
Russia	2·0	3·3	0·6
India	2·2	3·0	0·7
Great Britain	1·0	1·0	1·0
Austria	2·0	1·4	1·4
Italy	2·0	1·25	1·6
Spain	2·2	1·2	1·8
France (modern) . . .	3·0	1·2	2·5
Prussia (modern) . . .	3·6	1·4	2·6

* The *weight* of triangulation varies inversely with its distance. The error of mean square increases with $\sqrt{\text{distance}}$, but in practice the terminal accumulation over a great length appears to be generally more due to systematic than to accidental errors.

† General Ferrero's report to the International Conference at Stuttgart in 1898.

The triangulations of South Africa and the United States are equal in precision to those of France and Prussia.

So long as a country is isolated, its survey will not concern itself with errors accumulated at its frontiers: a country like Prussia whose triangulation meets other triangulations on all sides, has experienced troubles that India has never felt. But India is losing her insularity and though the loss may be slow it is certain. Fifteen years ago the Indian frontier topographers began to experience embarrassments, because the longitudes of Indian mapping were 2¼ miles in error. It was futile to tell them, that an error of 2¼ miles in 6,000 miles was a small matter; the error was not dispersed over the 6,000 miles between Greenwich and India: it came in between our Indian and Afghan topography. The frontier surveyors suggested that each meridian should be drawn in two places on all Indian maps, and they subsequently proposed to project trans-frontier maps in terms of Europe instead of in terms of India, thus transferring the 2¼-mile gap from their front to their rear. It was the topographical surveyor and not the scientific branch, that was experiencing the trouble. The incident teaches that an error of 2¼ miles may remain unnoticed during a century of insularity, but that at the first appearance of a small scale trans-frontier survey it begins to cause embarrassment.

The accuracy of European surveys gradually increased throughout the nineteenth century, and the difficulties of adjusting the discrepancies between contiguous triangulations became ever correspondingly greater. Eventually it was agreed to create a permanent court of arbitration, and the International Geodetic Association, to which all civilised nations now belong, was called into being.

Its Errors.

The triangulation of India has been controlled by base-lines: its errors of length do not, therefore, need consideration.* But base-lines exercise no control on direction, and if our astronomical results are to be believed, the triangulation has exhibited a constant tendency to deviate from the true course. Between Karachi and Calcutta an error in azimuth of 11″ has been generated, and this has increased to 15″ at Mandalay: our trigonometrical points in Eastern Burma have consequently been all displaced some 400 feet too far south. Between Cape Comorin and Peshâwar an azimuthal error of 12″ has been generated, and the relative orientation of these two places is 200 feet in error in consequence.

But the chief errors in the framework of Indian mapping are due not to faults in its construction, but to its location on the globe. Owing to errors in the original observations of longitude the Indian area has been placed on the globe 2¼ miles too far east: owing to obstacles placed by nature in the way of correct determinations of latitude in Central India, the Indian area has been located some 600 feet too far north on the globe.

Owing mainly to the deformation of the geoid in India, Everest's figure of the earth, on which all our calculations of latitudes and longitudes are based, has been given a diameter too small by 2 miles; the result is that our maps, though correct in their detail, have all been given too large a share of the earth's surface: our distance from Peshâwar to Cape Comorin has been accurately measured, but we have given it in our maps 11 seconds more of latitude than it has a right to: our distance from Karachi to Mandalay has been made to embrace 17 seconds more of longitude than it is entitled to. At present we have no neighbours complaining of these overlaps, and the time has not come for us to trouble about them: it would in fact be premature for us to adopt a new figure, when great earth measurements are now in progress in Africa and America, and it would be premature for us to attempt a new location of India on that figure, until our pendulum and astronomical work has been extended.

If we sum up the errors in position accumulated on our frontiers, they are as follows:—

Peshâwar has been placed too far north in latitude by 400 feet owing to figural errors, and by 600 feet more owing to errors of location on the globe: it is thus shown on our maps 1,000 feet too far north. Peshâwar is, moreover, shown 2¼ miles too far east of Greenwich.

The Salween has been placed in longitude 1,100 feet too far east owing to figural errors, and 2¼ miles too far east owing to errors of initial longitude; it is thus shown on our maps 2¾ miles too far east. The Salween is shown some 300 feet too far north, the effects of the initial latitudinal error and of the accumulated azimuthal error being opposite in East Burma.

It is difficult to define numerically the meaning of an "embarrassing accumulation of error," because as a survey matures it begins to feel the pinch of errors, which it failed to notice in its youth. Any accumulation of error is embarassing, that obliges surveyors to recalculate their data. Changes in data due to revisions of computations, even when such revisions are based upon important new observations, cause great inconvenience, and decrease the value of the data for co-ordination purposes.

In dealing with problems connected with the determination of the figure of the earth no inconvenience arises from using revised data, and it is relatively easy to make revisions, as comparatively few points are concerned.

When triangulation is being used for controlling maps and co-ordinating surveys, the aim of adjustment is to avoid purely local distortions; but when it is being employed to

* In the 747 miles separating Karachi and Attock the error in *length* accumulated in the triangulation, and eliminated by the measurement of the Attock Base-line, was 99 feet.

investigate the form of the geoid, it is of importance only to have correct relations between very distant points. In discussing then the meaning of "embarrassing accumulations of error," we have only to consider the geographic purposes of triangulation, and we can dismiss from our minds the geodetic.

There is no doubt that the error of 2½ miles in longitude has already become embarrassing to India: our $\frac{1}{1,000,000}$ maps have different longitudes to our 1-mile maps, and our 4-mile maps have longitudes differing from the other two, and these discrepancies must be inconvenient to the great body of map-users, who are not in the secret of the longitude footnotes. The longitude error is in fact so large that it will probably, in the future, necessitate a revision of data: and if such a revision comes to be carried out, the opportunity will doubtless be taken to eliminate also our figural and latitudinal and azimuthal errors.

As to the error of 1,000 feet in the latitude of the triangulation at Peshâwar, this accumulation causes at present no inconvenience: but if our triangulation ever comes to be connected with Russia's, the overlap in latitude will amount to half a mile or more, because Russia is projecting her triangulation on too small a spheroid, just as we are doing. The two surveys will then have different values of latitude for every boundary pillar; it is impossible to foresee now what course they will agree to take: but if we may judge from examples in Europe, they will refer to the International Association, and they will perhaps be advised to correct their data.

Its cost.

In a Parliamentary paper published in 1851, Sir A. Waugh estimated the cost of the principal triangulation at Rupees 7-2-5 per square mile. If the same work were to be executed now, it would probably cost double. Since the estimate was prepared, triangulation has been carried over Rájputána, Sind and the Punjab, at a cost averaging 15 Rupees per square mile. The average original cost of the whole principal triangulation of India may be estimated to have been about 9 Rupees per square mile. This cost applies to the area actually triangulated, and not to the total area controlled.

In 1798, Colonel Lambton started working on the network system, but in 1824 Colonel Blacker and Colonel Everest substituted the gridiron system, and by so doing greatly reduced the cost. The whole area of India is almost three times as large as the area triangulated, and as the whole has been controlled by principal fixings, the cost of the triangulation works out at about 3 Rupees per square mile. The cost of a 1 inch = 1 mile survey exceeds generally Rupees 20 per square mile, and amounts at times to Rupees 40 or more. The secondary and tertiary triangulation on which a 1 inch survey is based, will cost 10 Rupees per square mile: the traversing on which a 1 inch survey is based in flat countries, will cost 15 Rupees per square mile. The principal triangulation will, therefore, increase the original cost of a 1 inch survey by less than 10 per cent.,—by less perhaps than the cost of its fair-mapping.

But a 1 inch survey requires to be periodically revised, and the principal triangulation remains available for all revisions. Moreover, surveys on larger scales than 1 inch are in progress throughout the country at costs varying from Rupees 60 to Rupees 200 per square mile, and these are all based on the same principal triangulation. Furthermore, it must be remembered that the true expense of our principal triangulation has not been its total additional cost, but its excess over the cost of the secondary triangulation, which would have had to be substituted, if it had not been executed.

The differences between our principal and good secondary triangulations have been as follows:—

(*a*) The principal costs perhaps 20 per cent. more than the secondary.*

(*b*) The principal stations are more solidly built, and the positions of the mark-stones are carefully protected for the use of the future.

(*c*) Our principal triangulation has generated an error in position of 200 feet and in azimuth of 12″ between Cape Comorin and Peshawar: our good and expensive secondary work such as the Quetta series, might easily have generated over the same distance an error in position of half a mile and in azimuth of 150″. Triangulation such as the Kalat series might well have generated between Cape Comorin and Peshâwar, an error in position of a mile and a quarter, and in azimuth of 400″. Secondary work, such as that observed with a 12-inch theodolite on the Cutch Coast, might have generated an error of 5 miles in position and of 20 minutes in azimuth.

Its uses.

It is a great mistake to imagine that the principal triangulation of India was executed for the purpose of measuring the figure of the earth. *The principal triangulation of India was executed to control the topography.* A triangulation, however, furnishes only the distances apart of the points fixed and their mutual directions: these data are not sufficient for topography, which requires the latitudes and longitudes of points. In order to convert the distances and directions of the triangulation into the latitudes and

* Secondary is cheaper than principal in that its progress is faster, but dearer in that its triangles are smaller. In clear weather and suitable country the extra size of the principal triangles will at times compensate the slowness of progress, and render the principal on the whole cheaper than secondary.

longitudes of topography, we require a knowledge of the earth's dimensions. When Lambton commenced the triangulation of India, the figure of the earth was not known with sufficient accuracy even for the calculation of the spherical excesses of his triangles. During his twenty-five years of trigonometrical work he was always, as he extended his triangulation, having to recalculate the earth's figure, and he died without having succeeded in obtaining a satisfactory result. In 1823, Everest attacked the problem, and in the belief that Lambton's arcs had been too short, he extended the triangulation northwards into Central India. To his great disappointment a careful determination then gave the polar diameter of the earth longer than the equatorial. Though this anomaly had been met with in other countries, Everest was convinced that the fault lay in his measurements and not in the theory of gravitation.

It was not till 1830, that Everest succeeded in obtaining a figure of the earth sufficiently accurate for the needs of topographers.

There is no doubt that Lambton's and Everest's unexpected difficulties attracted much attention in Europe: these officers were testing in the field the great Newtonian theory that the earth was an oblate spheroid, and their instructive failures took the scientific world by surprise. But the interest excited in their work does not alter the facts, that the principal triangulation was executed for the control of topography, and that its utilisation for figural determinations was incidental.

The *first* great practical use of the principal triangulation has been its prevention of embarrassing accumulations of errors at our frontiers.

Its *second* use has been to unify and co-ordinate all the separate surveys of Madras, Bombay, Sind and Bengal; to give them one origin; to combine them into one harmonious whole: to get rid of gaps and overlaps from the internal mapping of India; to free India from the internal boundary disputes that have so troubled other countries.

Its *third* use has been to facilitate and cheapen by tower stations, the topographical surveys of the extensive plains of Upper India, a difficult country to map, being the only large portion of the earth's surface that is flat, intricate and valuable.

Its *fourth* use has been to enable the positions and heights of distant peaks to be determined with accuracy all along our trans-frontier, and thereby to afford points to topographers in Afghanistan and Tibet.

Its *fifth* use has been to furnish perpetual points for the use of posterity, without which revisions of maps would be impossible.

Its future.

The questions, that arise concerning the future of the principal triangulation, have to do firstly, with the preservation of its stations, and secondly, with its extensions.

The measures that have been taken to preserve the stations have not been altogether successful, and require I think to be supplemented—but not supplanted—by departmental inspections: furthermore, seeing the importance of preserving all these marks intact I think that a call by the Government of India for a special report on the condition of all existing stations, if made every 20 years, would tend to prevent the protective work from degenerating into routine.

The only future extensions of triangulation that require present consideration are those of Burma and Baluchistan. In Burma the completion of the Great Salween series, the extension of the Mandalay Meridional series to Sadiya, and the revision of the Assam Valley, triangles are required to consolidate the triangulation east of Chittagong and Gauhati.

A principal series is being carried westwards from Kalat in order to co-ordinate the separate surveys that have been made of recent years in Baluchistan, and to provide a foundation for other surveys that are likely to be required in those regions in the near future.

If we are to follow the practices of European nations, of the United States, and of South Africa, we should arrange to measure two or three base-lines in Burma, and possibly one in Baluchistan within the next few years.

The following table shows the numbers of base-lines of the first class, measured in various countries:—

	No. of Base-Lines.*	Area triangulated, in thousands of square miles.	Ratio of Base-Lines to area.
Italy	9	110	$\frac{1}{12}$
Germany	13	204	$\frac{1}{15}$
Great Britain	6	121	$\frac{1}{20}$
France	7	207	$\frac{1}{30}$
Russia	19	2,000	$\frac{1}{105}$
India	10	1,520	$\frac{1}{152}$
Burma	0	240	0

* General Ferrero's report to the International Conference at Stuttgart in 1898.

There is a base-line at Mergui in South Burma, but its length of 3 miles is too small to allow of its being classified as first class. The base-lines in India Proper are completed and though it is a matter of regret that the projected base-line at Bombay was omitted, the question is closed: whether our distant successor will re-open it will depend upon the future developments of geodesy.

In the above list there is little doubt that the 2,000,000 square miles allotted to Russia are in excess of her triangulated area: prior to 1895 good triangulation had been carried over Western and Southern Russia, Finland, the Caucasus and the Cis-Caspian Provinces: and a great arc of parallel had been taken eastwards from Warsaw to Orenburg, and was being extended into Central Asia.

THE LEVELLING OPERATIONS.

Their uses.

Levelling operations conducted on scientific principles form as essential a part of a survey as triangulation. Levelling constitutes the framework that controls the vertical measurements of a survey, just as triangulation controls the horizontal measurements. In addition to affording a basis for topographical heights, Levelling contributes to topography by co-ordinating the Canal and Railway levels and rendering them available for maps.

Errors of vertical angles.

The altitudes entered on Indian topographical maps have been mostly derived from vertical angles: the degree of accuracy with which these angles have been measured, has varied from those observed to decimals of a second with large telescopes to those observed to the nearest degree with wooden clinometers. Our levelling operations have brought to light the following errors in the first-class heights of the principal triangulation:—

Madras Coast	5 feet too high
Bombay Coast	17 " " "
Mysore	9 " " "
Deccan	7 " " "
Cutch Coast	11 " " "
Khándesh	14 " " "
Punjab	5 " " "
Ganges Valley	errors varying from 13 " " " to 31 feet too low.

Errors of height amounting to 20 and 30 feet are of but little importance in mountainous regions, but are liable to mislead engineers who have to study the hydrography of the plains.

To take a well-known example—Ambála is in the Indo-Sutlej basin and its height is 902 feet: Saháranpore is in the Gangetic basin and its height is 903 feet. From Ambála to Saháranpur the ground rises 11 feet in the first 20 miles; the natural watershed between the drainage systems of the Arabian Sea and the Bay of Bengal is 913 feet high near Mustafabad railway station: the ground then falls 7 feet in the 13 miles to the Jumna, and 3 feet in the 17 miles between the Jumna and Saháranpur.

Work in hand.

The work in hand at present in connection with Levelling may be classed as follows:—

(1) Erection of standard bench-marks.
(2) Extensions of lines of levelling in the field.
(3) Preparation of level charts.
(4) Preparation for press of half a century's levelling results.

The scheme of erecting standard bench-marks has been initiated this winter. From information received at different times there are reasons to fear that numbers of ordinary bench-marks are destroyed, when towns expand and when railways or roads are widened. In the last few years we have discovered that the bench-marks between Rangoon and Mandalay have not maintained their original altitudes: the discovery was accidental; we had not intended to revise the Burmese levels. Revisions in India might bring to light similar displacements. We now propose to erect standard bench-marks in the important towns of India: these new marks will be solidly built in carefully chosen places, and will be handed over to the local engineers who will report to the Survey annually: their heights will be determined by levelling and engraved on the stones.

Projected extensions.

The lines of levelling that remain to be executed may be divided into three classes:

(i). The scientific, which are required to close circuits and to furnish the closing errors for the forthcoming adjustment of the level net. These amount to 6 years work.

(ii). The engineering, which are required by the Public Works Department to control and unify their Canal and Railway levels. These amount to 17 years work.

(iii). The protective, which are required to fix the heights of our standard bench-marks and to preserve thereby for posterity, a few of the altitudes determined in our time. These amount to 20 years work.

Of these three classes the third is of supreme importance; to postpone, however, the lines of levels required by the Public Works Department for 20 years, is practically to omit them altogether.

For many years past the levelling detachment has been assisting the Public Works Department, and has furnished bench-marks to the Bengal State Railways, to the Burma Railways, to the Burma Irrigation Department and to the Irrigation Department of Sind. There has been no opportunity of completing the scientific lines, which are wanted to consolidate the network.

The preparation of Level Charts was commenced thirty-eight years ago: 34 Charts have been published, and 112 remain. Level Charts are intended to show all Canal and Railway levels in terms of the datum of the Survey, and will be of use to both engineers and topographers.

Comparison with Foreign Surveys.

I have endeavoured to ascertain the amount of levelling executed in Europe and America, but it is difficult to obtain statistics: in all countries the publication of results lags behind the fieldwork.

India: Up to May 1904, there had been executed in India 15,500 miles of precise levelling.

Great Britain: Prior to 1861, the Ordnance Survey had executed 4,000 miles of accurate levelling in England and Wales, 3,000 miles in Scotland and 1,500 miles in Ireland. These operations have been widely extended since 1861.

France: Prior to 1898, France had carried out (*a*) 7,000 miles of levelling of the highest degree of accuracy, (*b*) 10,500 miles of a class of levelling, denominated by her surveyors second class, (*c*) 4,900 miles of so-called third class, (*d*) 10,200 miles of so-called fourth class. The lower orders of levelling are used in France to break up the fundamental network into smaller areas.*

United States: In 1899, the Survey adjusted their precise level net; 19,753 miles of precise levelling were included in the net: between 1899 and 1903, additional first class levelling extending over 6,000 miles was carried out.*

Germany: Prior to 1892 Germany had carried out 18,600 miles of first class levelling, and Austria had carried out 10,000.*

Japan: Prior to 1898, Japan had carried out and projected 5,700 miles of levelling of precision.*

Ratio of first class Levelling to area:—

Germany in 1892	$\frac{1}{11}$
Great Britain in 1861	$\frac{1}{14}$
Austria in 1892	$\frac{1}{21}$
Japan in 1898	$\frac{1}{22}$
France in 1898	$\frac{1}{26}$
India in 1905	$\frac{1}{110}$
United States in 1899	$\frac{1}{116}$

Seeing how valueless large portions of the Indian area are, no one could advocate that the ratio for India should be raised to that of Grert Britain. American surveyors would probably take exception to the ratio allotted to their country, as it makes no allowance for the large unsurveyed regions that form part of the United States.

In adjusting the errors of her levelling net, France had to take into account, that her lines had been connected with those of foreign countries at 18 different points, *viz*:—

with Spain at three points
with Italy at three points
with Switzerland at five points
with Germany at three points
with Belgium at four points

Owing to the errors in her connections with France, Switzerland had to revise 80 miles of levelling in 1896 and 183 miles in 1897. India's insularity renders her levelling independent of foreign checks.

Their Cost.

Seeing how useful our levelled heights and bench-marks have been in India to the engineering departments, it is questionable whether we ought to charge the total expenditure on them against topography. If, however, we decide to do so, the cost to topography of the levelling control, up to the present time, will work out at about nine annas per square mile of area controlled.

On the average four bench-marks have been erected in every 1-inch standard sheet of surveyed area.

THE ASTRONOMICAL OPERATIONS.

Primary aims.

The primary duty of the Astronomical party is the location of India in its correct position on the globe. The origin of our triangulation is a point in Central India: we have had

* Reports of the International Conferences, Stuttgart 1898, Paris 1900, Copenhagen 1902.

to determine astronomically the terrestrial position of this point, and we have had to determine astronomically the terrestrial directions in which our several diverging series of triangulation have trended; one series has run into Makran, others into the Punjab and Himalayas, others into Assam and Burma, others into South India, and in spite of unremitting care, all these ramifications have developed errors of orientation and direction.

The area of India is more than one-fourth of the total triangulated area of the world: it is the largest triangulated area that has yet been undertaken by one survey; it is the largest triangulated area that has ever been made to emanate from a single point; and our astronomical officers have had to fit this area into its true position on the globe. They have had to discover the relative dimensions of the area to be located and of the globe receiving it: they have had to keep a watch on the triangulation, to see that it is not trespassing beyond our correct frontiers and coasts, and to warn us of the errors that we shall have to deal with when we meet with a foreign survey.

It must be remembered that nature has placed obstacles in the path of astronomical surveyors in India: the direction of gravity is the only test they have of verticality, the surface of liquid at rest is their only test of horizontality, and in no other part of the world has the direction of gravity been found to undergo such abnormal variations, as have been discovered by the Russians in Fergana and by ourselves in Northern India: in no other country does the surface of liquid at rest deviate so much from the horizontal.

There appears to be an idea that the primary object of our astronomical work is the investigation of mountain attraction, and of deflections of the plumb-line. But this is a mistake. Its true goal is the determination of the geographic errors of area, shape, and position, that have been generated by the triangulation. But just as the triangulators found themselves unable to control the topography without a knowledge of the figure of the earth, so have the astronomers found themselves unable to control the triangulation without a knowledge of the direction of gravity. Just as the triangulators had to digress, and make earth-measurements, so have the astronomers had to halt on their way to investigate the attractive effects of mountains.

It is true that discoveries made in the course of these secondary operations have won the interest and sympathy of learned societies in Europe: the discovery that an extraordinary deficiency of matter underlies the Himalayas, that a range of mountains is hidden and buried beneath the plains of Central India, that seaward deflections of gravity prevail round the coasts of southern India,—these discoveries have led geologists and geodesists to press for a further investigation of the distribution of mass in the earth's crust. But the interest that has been awakened does not alter the fact, that the primary object of our astronomical operations is geographic.

The heights of Himalayan peaks.

Difficult questions have arisen in connection with the heights of the Himalayan and trans-frontier peaks: our values for these heights are in error, (*1stly*) because of the extraordinary deformation of the level surface at the observing stations in submontane regions; *2ndly*) because of our ignorance of the laws of refraction, when rays traverse rarefied air in snow-covered regions; (*3rdly*) because of our ignorance of the variations in the actual heights of peaks due to the increase and decrease of snow. It is part now of the programme of the Astronomical party to determine the errors in height arising from geoidal deformations, to investigate the laws of refraction at high altitudes, and to measure the actual variations that are occurring in the heights of peaks.

There are but three known methods of determining the height of a station, *viz.*, (1) By Spirit Level: (2) By Atmospheric pressure: (3) By Angular measurement. Of these three methods the first two require the station itself to be visited, and the third alone is available, when the station is inaccessible.

To obtain an idea of the degree of uncertainty which attaches to values of heights determined from very distant observing stations, we may suppose that an observer measured the elevation of Mount Everest from Darjeeling in October, and again from the plains of Bengal in April; his second series of observations might give a larger value of height than his first series by 100 feet on account of geoidal deformation, by 300 feet on account of inequalities in refraction,* and by 100 feet or more on account of increase of snow,—by 500 feet in all.

I do not presume to argue that our heights are in error by this amount, but I do say that the above figures give a fair numerical idea of the range of uncertainty. Apart from topographical requirements, it is of interest to the world at large to know the heights of the highest points of the earth, and the duty of determining them belongs to the Indian Survey.

The values of height now attaching to the three highest mountains in the world are by no means the most probable.

Heights of the three highest mountains in the world.

	Present Survey values of height.	Most probable values.
Mount Everest	29002	29141
K_2	28250	28191
Kanchinjinga	28146	28225

* Refraction is probably less at Darjeeling than over the plains: if, therefore, the same co-efficient be employed the height obtained from Darjeeling will be less than that obtained from the plains.

It is possible that we are robbing Kanchinjinga of the honor of second place.

My most probable values of height have been derived from observations of refraction that were not available when the present Survey values of height were adopted. It would, however, be premature to exchange yet our present values for the most probable values, for nothing leads more to confusion than repeated alterations of data.

It is true that the values at present most probably would be improvements on the accepted values, but we want something more than improvement or correction to justify us in changing data: we want finality and certainty, and these we shall never attain, until we appreciate the magnitude of the problem, and go systematically to work. In the course of the Trigonometrical Survey we have accumulated a mass of evidence relating to refraction, but it is entangled with the effects of local attraction and of snowfall, and it cannot be classified or utilised, until we have disentangled the three.

Special duties in the past.

The Astronomical party of the Survey has been often called upon in the past to perform miscellaneous duties that would in Great Britain have fallen upon the staff of Greenwich Observatory. It has had to observe Transits of Venus: in 1894, 1895 and 1896, it was observing in Persia and Europe to determine the error of Indian longitudes: in 1898, it was deputed to assist the Astronomer Royal in observations of the total Eclipse of the Sun. It has worked in conjunction with the Government Astronomer at Madras to obtain a fundamental value of latitude for the Indian Star Catalogue.

Special future work.

The Director of Kodaikánal Observatory requested the Survey some years ago to determine his geographical co-ordinates both astronomically and by triangulation: I regard this request as of first importance, but no officers have been available for the work.

It is to be hoped that in the future the Astronomical party may be given an opportunity of determining the mean density of the earth: Astronomers Royal did this for Great Britain at Schichallion and Cardiff, and the Ordnance Survey made a fine determination at Arthur's Seat at Edinburgh. The three measures were, however, not accordant*, and a determination in the low latitudes of India would be a valuable contribution. The present time is peculiarly opportune, because we could count upon the co-operation of our pendulum party: in no one of the British determinations could astronomical and pendulum observations be combined. When, therefore, the Ordnance Survey had to deduce the weight of the earth from the weight of Arthur's Seat, they were not aware of the density of the crust underlying Arthur's Seat, and they were obliged to assume that it was normal: if we undertook to measure now the relative weights of the earth and Mount Abu, we could with our pendulums discover, whether the foundations of Mount Abu were abnormally heavy or light.

Comparison with Foreign Surveys.

The errors in the geographic position and area and shape of a survey are determined by Astronomical measurements of latitude, longitude and azimuth, at stations of its triangulation. The following table shows the present position of the Survey of India as compared with other surveys: —

Survey of	The proportional number of stations of the triangulation at which Astronomical observations have been made.†		The total number of Arcs of longitude measured.‡
	For Latitude.	For Azimuth.	
Germany	1 in 3	1 in 4	107
Trans-continental triangulation of America	1 in 2	1 in 3	67
Great Britain	1 in 7	1 in 4	‡
Austria	1 in 6	1 in 7	95
France	1 in 8	1 in 11	62
Italy	1 in 11	1 in 12	34
Russia	1 in 12	1 in 12	81
India proper	1 in 11	1 in 12	47
Baluchistan	0	0	2
Burma¶	0	1 in 11	5
Kashmir	0	0	0

* Mr. Maskelyne at Schichallion . . . 4·56
Sir George Airy at Cardiff . . . . 6·57
Sir Henry James at Edinburgh . . . 5·32

† Reports of the International Conferences at Stuttgart 1899, and at Copenhagen 1903.

‡ Many of the arcs of longitude measured by Great Britain, cross the English Channel and the Atlantic: it is doubtful whether these should be included in the table.

¶ Including the Manipur Meridional series.

Normal future work.

Observations for latitude are still much wanted on branches of our triangulation, more especially in Burma, Baluchistan, Kashmir and the Himalayas.

Observations for azimuth will be required on future extensions of the triangulation.

The measurement of a few additional arcs of longitude in Burma, the Punjab, South India and Kashmir, has for many years been considered desirable.

International determination of the variation of latitude.

Of recent years endeavours have been made in Europe and America, to measure the changes in the positions of the earth's centre of gravity and of the earth's rotation axis; that changes are always going on has been made clear by the discovery that the latitude of every place is continually varying. Some few years ago an International Congress decided that a systematic investigation should be made, and they suggested that the earth should be surrounded by a girdle of special observatories. The parallel of 39° north was selected for the girdle, with the result that three observatories fell in the United States, one in Japan, one in Russia, one in Sardinia. The Russian Government was asked in accordance with this scheme to erect an observatory at Tschardjui: Russia had been already for some years observing the variations of latitude at Pulkowa, at Moscow, at Warsaw, and at Kazan, and the new observatory at Tschardjui made her fifth. India has so far not been asked to contribute to this work: she profits nevertheless from the results.

The Pendulum Operations.

The progress of foreign surveys.

The number of stations, at which the pendulum had been observed prior to 1903, were*—

Great Britain	63
Italy	193
France	89
Austria	569
Germany	280
United States	108
Russia	153
India	29

Pendulum observations are now being taken by the surveys of France, Germany Russia, Austria, Italy, Japan and the United States.

France has volunteered to undertake a gravimetric survey of the Andes: Germany has undertaken one of the oceans and coast lines of the world; the United States and Russia have enormous areas of their own; and Great Britain sent a complete pendulum equipment to the Antarctic two years ago.

But, for pendulum research the most interesting place on the earth is the mountainous region of Northern India, and the International Conference that met at Copenhagen in 1903, passed the following resolution on this subject for submission to the Government of India.†

"Il est desirable qu'on fasse dans les Indes anglaises une étude approfondie de la "répartition de la pesanteur, tant dans les contrées montagneuses que dans les plaines.

"Attendu que c'est seulment par cette étude qu'on pourra obtenir une representation "exacte de la distribution des masses dans l'écorce terrestre et de la forme du géoide dans "ces contrées."

The British Ambassador at Berlin submitted the above resolution to the Government of India on October 6th, 1903. Pendulum observations were commenced in India in 1904.‡

The purposes served by Pendulum observations.

Pendulum observations are of use—

(*1stly.*)—For correcting and perfecting our astronomical checks on the triangulation.
(*2ndly*).—For determining the earth's ellipticity by a method independent of arc-measurements.
(*3rdly*).—For investigating the departures of the geoid from a Newtonian spheroid.
(*4thly*).—For investigating the constitution of the earth's crust.

The first purpose served by pendulum observations is, therefore, geographic, the second and third are astronomic, the fourth is geologic; all are geodetic.

We are profoundly ignorant of the constitution of the earth: we do not know if its interior is rock or metal, solid or molten: we talk of its crust, but we do not know if it has a crust distinct from its core: we do not know if the existence of high mountains is an incident of the earth's surface only, or if their superincumbent weight is producing inequalities of density at great depths. We do not know how these mountains have arisen. Pendulum operations have consequently a high value and interest for geologists and geodesists.

* Reports of the International Conferences at Paris in 1900 and at Copenhagen in 1903. Observations at 29 pendulum stations in India were made between 1866 and 1871; the work was stopped because the only apparatus procurable was too heavy and wearisome. Of the 63 stations appertaining to Great Britain, but 16 fall in Great Britain itself; the remainder, though occupied by British observers, fall in Spitzbergen, South America, and other places.

† See A proceedings No. 2, December 1903, Department of Revenue and Agriculture, Government of India.

‡ The Surveyor General had obtained the sanction of Government to the purchase of a pendulum apparatus in 1902, and thus anticipated the wish of the International Conference.

Geographical, astronomical and geological observations have all in their turn revealed peculiar physical features in the Himalayas, and we are now calling the pendulum to our aid to supplement our knowledge of Himalayan structure.

But when discussing the numerous uses of pendulum observations, we must not lose sight of the important fact that the pendulum is primarily a surveying instrument.

The connection between topography and pendulum work is, however, too complex to be described clearly in a single sentence, and must be traced step by step, as follows:—

(i) The geographical adjustment of the triangulation is dependent upon astronomical observations.

(ii) The correctness of astronomical observations depends upon the direction of gravity.

(iii) We cannot *measure* the direction of gravity, because we havs no zero from which to measure. We can measure the *height* of a station, because the mean level of the sea is a reliable zero, we can measure *temperatures*, because the freezing point of water is a reliable zero: we can measure the deviation of the needle from true north. But we cannot measure the deviation of gravity from the true vertical, because the true vertical is not discoverable by observation as the true north is.

(iv) Owing to the deflections of gravity, astronomical measurements may cause an error of 800 or 1,000 feet in the geographical position of any point, and an error of a mile in the position of a Himalayan point.

(v) No deflections of gravity would occur on a perfectly level spheroid formed of homogeneous spheroidal layers: they are caused by the irregular distribution of masses at the earth's surface and in the earth's crust. The pendulum is required to demonstrate the true distribution of mass, and to show to us the extent to which our actual earth differs from a level spheroid composed of homogeneous layers.

(vi) If we know the mean density of the earth and the local distribution of mass at its surface, we can calculate the amount that gravity will be deflected from the normal. By providing us, therefore, with an ideal spheroid the pendulum supplies the zero which nature has failed to furnish.

The primary use then of pendulum work is that it enables the surveyors to correct their astronomical results for the unavoidable errors caused by deflections of gravity. The location of India on the globe has, for instance, rested upon astronomical observations made at a point in Central India. Everest selected this spot because there were no mountains visible, and because it seemed to be a place at which the direction of gravity would be truly vertical, and at which the instrumental levels would be truly horizontal. But only in the last few years we have discovered that Everest's point is situated on the scarp of a buried range or table-land; this range is deflecting gravity out of the normal, and must have disturbed the horizontality of Everest's levels; pendulum observations will disclose the mass and position of the hidden range, and will enable us to compute corrections for the astronomical results.

Thus it will be seen that pendulum observations are used to control astronomical results, just as astronomical observations are used to control the triangulation, and as the triangulation is used to control the topography: all are links in one chain.

THE TIDAL OPERATIONS.

Retrospect.

The investigations and writings of Professor George Darwin have within the last thirty years, considerably increased our knowledge of the tides. Though we are still unable to foretell the course of the tides at places where no observations have been taken, yet our predictions at ports at which the tides have been observed, are now attaining an accuracy which would not have been credited half a century ago.

Tidal operations in India were initiated for the following purposes:—

(1) To provide a datum for the levelling operations of the survey.

(2) To afford data for the calculation of tidal predictions.

(3) To obtain evidence of the rising and sinking of land and of variations in mean sea-level.

Up to 1883, predictions of the tides were calculated by an arbitrary method which made no allowance for what is known as the diurnal inequality.*

In home waters the diurnal inequality is practically absent, and the European admiralties and surveys have never been really troubled by it. But in Indian waters it is very large, so large that in some of our ports at certain times there is only one tide in 24 hours. Owing to this phenomenon the earliest attempts at tidal prediction which were made in India for Karachi and Bombay, were not successful; and for many years all endeavours to foretell the tides at Aden failed. In 1883, Darwin revised the method of Harmonic Analysis as applied to the tides, formulated by Sir William Thomson in 1872, and we are now able to unravel their extreme complication in Indian waters. The average error in the

* This inequality is easily understood from a diagram.

predicted height of high water at Aden is now one inch. If we reflect that the motions of the sun and moon, the complex outline of our coasts, the ever-varying depths of the sea, and the earth's rotation and figure are all involved, we cannot but regard modern tidal prediction as one of the greatest triumphs of science.

India was the first country to adopt this method of prediction: her success has been extraordinary, and her example has been slowly followed by Canada, the United States, by France, and other European nations.

By means of Harmonic Analysis we can separate the observed tides into twenty-four components, and by means of Lord Kelvin's tide-predicting machine we can again combine these components, and discover mechanically the actual tides of the future. For many years India was the only country that possessed a tide-predicting machine: but latterly France, the United States, and Canada have had machines constructed. The tide-predicting machine of the Indian Government has been used in Europe for the tidal predictions of British colonies, and for this reason has never been sent to India. For many years it stood at Lambeth, but has lately been received at the National Physical Laboratory at Teddington.

The predictions of the Indian tides are carried out under the following quadruple arrangement:—

(i). The tidal observations are taken under the superintendence and orders of the local port officers and engineers.

(ii). The Survey of India has the duty of inspecting the several tidal observatories and of maintaining uniformity of method: the Survey of India has the further duties of reading off the tidal diagrams and of calculating by Harmonic Analysis the twenty-four tidal components.

(iii). The National Physical Laboratory in England sets the tidal machine to accord with the results of our calculations, and prepares the tidal predictions from the curves drawn by the machine.

(iv). From the beginning, the operations have been under the scientific direction of Professor Darwin, whose advice has been constantly sought.

If tidal observations are taken for 5 years, sufficient data are accumulated to enable predictions to be made; the present predictions for some of the Indian ports are being still based upon observations taken more than twenty years ago and continue to be accurate. But lest in the course of years the tides may be slowly varying, or lest the relative heights of sea and land may be altering, a few observatories have been established on a permanent basis.

Between 1874 and 1904, tidal observations were taken at 42 places: of these observatories 34 were temporary and 8 permanent. At the present time one temporary observatory and the eight permanent are working.

Of our 42 tidal observatories two were in the Red Sea, two in Arabia, one in the Persian Gulf, one in the Maldives, three in Ceylon, one in the Andamans, twenty-four in India and eight in Burma.

Comparison with foreign surveys.

The levelling results have been tested against tidal determinations of mean sea-level at 20 different places on the coasts of India.

In Great Britain, prior to 1861, the levelling results of the Ordnance Survey had been compared with tidal measurements of sea-level at 30 places in England and Wales, at 18 places in Scotland and at 21 places in Ireland.*

The following table shows the number of permanent tidal observatories working in 1902:†—

Country.	Length of Coast-line in miles.	No. of tidal Observatories.
Tonquin (France)	150	1
Austria	300	1
Holland	400	20
Denmark	500	10
Algiers (France)	600	1
Germany	800	26
New South Wales	800	3
France	1,300	11
Italy	1,600	16
Canada	2,000	7
Russia	2,000	10
Japan	2,600	10
New Zealand	3,000	6
Great Britain	3,000	9
India	4,000	8

* Abstracts of Spirit Levelling, Ordnance Survey, 1861.
† International Conferences, Stuttgart, 1898, and Copenhagen, 1903.

Future work.

The following tidal work will be carried out by the Survey of India in future :—

(i). Maintenance of 8 permanent tidal observatories.
(ii). Annual calculations for the tide-predictions for 42 different ports.
(iii). Opening of new tidal observatories, of which two have been proposed for the Malay Peninsula, one for the Red sea and two for the Gulf of Cutch.

Scientific Investigations.

Up to a few years ago it was generally held by geologists that the earth was a globe of molten matter enclosed by a thin crust. Lord Kelvin has, however, shown that such a globe would yield to tidal forces, and that the oceanic tides would then be imperceptible. The oceanic tides consist in a motion of the water relatively to the land, and their existence proves that the land does not yield with perfect freedom. From the fortnightly tide observed in Indian waters, Lord Kelvin and Professor Darwin have shown that the earth possesses a rigidity greater than that of solid glass, though not greater than that of solid steel.

In my previous note on Astronomical work I alluded to the variation of latitude : this phenomenon has been attributed to shiftings of the earth's axis of rotation, to movements of the earth's centre of gravity, and to variations in the position of the equatorial protuberance with reference to places fixed on the earth's surface: as the axis of rotation and the centre of gravity and the equatorial protuberance shift, the oceans become disturbed, and a tide becomes generated. We are endeavouring now under the direction of Professor Darwin, to detect a tide at Karachi corresponding in its period of 430 days with the variation of latitude : the United States Geodetic Survey have discovered such a tide on their coasts, and the Geodetic Survey of Holland has also detected it. This tide is of course minute, as the movements of the earth's axis are small : if the displacements of the axis were considerable, whole continents would be drowned by gigantic waves.*

THE MAGNETIC SURVEY AND SOLAR PHOTOGRAPHY.

A Magnetic Survey of India was proposed in 1896 by Sir John Eliot and General Strahan, and was recommended by the Astronomers who visited India in 1898, on the occasion of the total eclipse of the sun.† At the outset there was some uncertainty as to whether the work should be undertaken by the Survey of India or by the Meteorological Department, and it was eventually decided that the field work should be carried out under the Surveyor General, and that the fixed observatories should be under the Meteorological Reporter. By mutual agreement, however, the Meteorological Reporter has now handed over the charge of four of the five observatories to the Surveyor General. The Magnetic Survey of India was begun in 1900.

Many branches of science are interested in a Magnetic Survey : the meteorologists require it to assist them in their investigation of the connection between sunspots and rainfall : the geologists expect it to show them the positions of magnetic rocks : geographers and navigators derive from it their knowledge of the declination of the compass, and the secular changes in the declination.

The existence of magnetic rocks in the crust can at times be detected by ordinary compasses, but if iron ore is lying concealed at any great depth from the surface, its presence would be only discovered by a systematic and rigorous survey.

Though the magnetic surveys of Europe and America have greatly progressed of recent years, but a small fraction of the surface of the globe has as yet been examined. We do not at present know whether the earth's magnetism is due to permanent centres of attraction or to its rotatary motion : we do not know whether the earth is a permanent magnet or not.

Date of Magnetic discoveries.

1492. Discovery that a needle does not point true north, and that its declination differs in different parts of the earth.
1576.* Discovery that the north end of a needle if properly balanced will dip below the horizon, and that the amount of dip differs in different parts of the earth.
1634. Discovery that the magnetic declination constantly undergoes slow changes in the course of years, and that the rate of its change differs in different countries.
1720. Discovery that the strength or intensity of the earth's magnetic force differs in different countries, and at different times.
1722. Discovery that the magnetic declination is subject to an appreciable diurnal tide, and that the range of this tide differs in different countries and at different seasons.
19th century. General Sabine shows that the earth's magnetism is not only a telluric but a cosmical force.

* Darwin's Tides: p. 230.
† See Reports by Sir W. Christie, K.C.B., F.R.S. and Sir Norman Lockyer, K.C.B., F.R.S.

The Indian Magnetic Survey.

The immediate aim of a modern Magnetic Survey is to determine the declination, the dip, and the intensity of the earth's magnetic force in every portion of the area involved, and to measure the several changes that these elements undergo.

In the Magnetic Survey of India five field parties have been observing the declination, dip and intensity, in different parts of India since 1900; annual observations have also been taken at 17 "repeat" stations to test the annual local variations in the elements; and continuous photographic records have been obtained at five observatories of the direction and intensity of the magnetic force.

The preliminary Magnetic Survey of India will be completed in 1906. Charts will then be prepared to show the localities where magnetic disturbances exist, and a detailed Magnetic Survey of those localities will be commenced under the guidance of the Royal Society.

In projecting the detailed survey, the Survey of India, conscious of a heavy responsibility, will rely upon the co-operation of the Meteorological Reporter and of the Director of the Geological Survey.

We have been much indebted to Sir Arthur Rücker, K.C.B., F.R.S., for his interest, advice and instructions, and we count with confidence upon the continued sympathy of this eminent physicist.

Comparison of the Magnetic Surveys of Great Britain and of India.

The first complete Magnetic Survey was that of Great Britain in 1837-38. The example set by Great Britain was followed by Austria, Germany, Holland, France, Canada Russia, Italy and the United States.

In 1857-62, after the lapse of 20 years, Great Britain repeated its original Magnetic Survey in order to investigate the changes that had occurred.

Between 1884 and 1888 Great Britain carried out a third Magnetic Survey, and between 1889 and 1892 it amplified this survey, and made it the most detailed of the world.

Our present Magnetic Survey is the first attempted in India, but magnetic observations have been taken since 1846 at the Observatory in Colába, which was established by the East India Company, and this continuous series is undoubtedly a very valuable record.

The following Magnetic Observatories are now working:—

In Great Britain.	In India.
Greenwich	Colaba
Kew	Kodaikanal
Stonyhurst	Dehra Dún
Valentia	Barrackpore
Falmouth	Toungoo

In Great Britain there were 26 "Repeat" stations, that is one "Repeat" station on the average to every 4,700 square miles.

In India there are projected 24 "Repeat" stations, or one "Repeat" station on the average to every 73,000 square miles.

In Great Britain there were 882 field stations, or one field station on the average to every 139 square miles.

In India there are projected 1,200 field stations or one field station on the average to every 1,500 square miles.

I am not making these comparisons to illustrate the inferiority of the Indian Survey to the British, but to show that the Magnetic Survey of India has been designed with a proper regard for economy, and that no undue multiplicity of observations is being contemplated.

It is possible that when the detailed Magnetic Survey is being undertaken, we shall be pressed to multiply field stations in regions of magnetic disturbance.

The following information is extracted from the last report of the United States Survey, dated Washington, 1904:—

"Observations have been made at 1,636 stations, of which about one-eighth are "repeat" stations: the average distance between the stations is 25 miles,* although in "regions of pronounced disturbances the distances are much less: the area covered is one-"third of the area of the United States."

"Observatory work has been carried on at five stations."

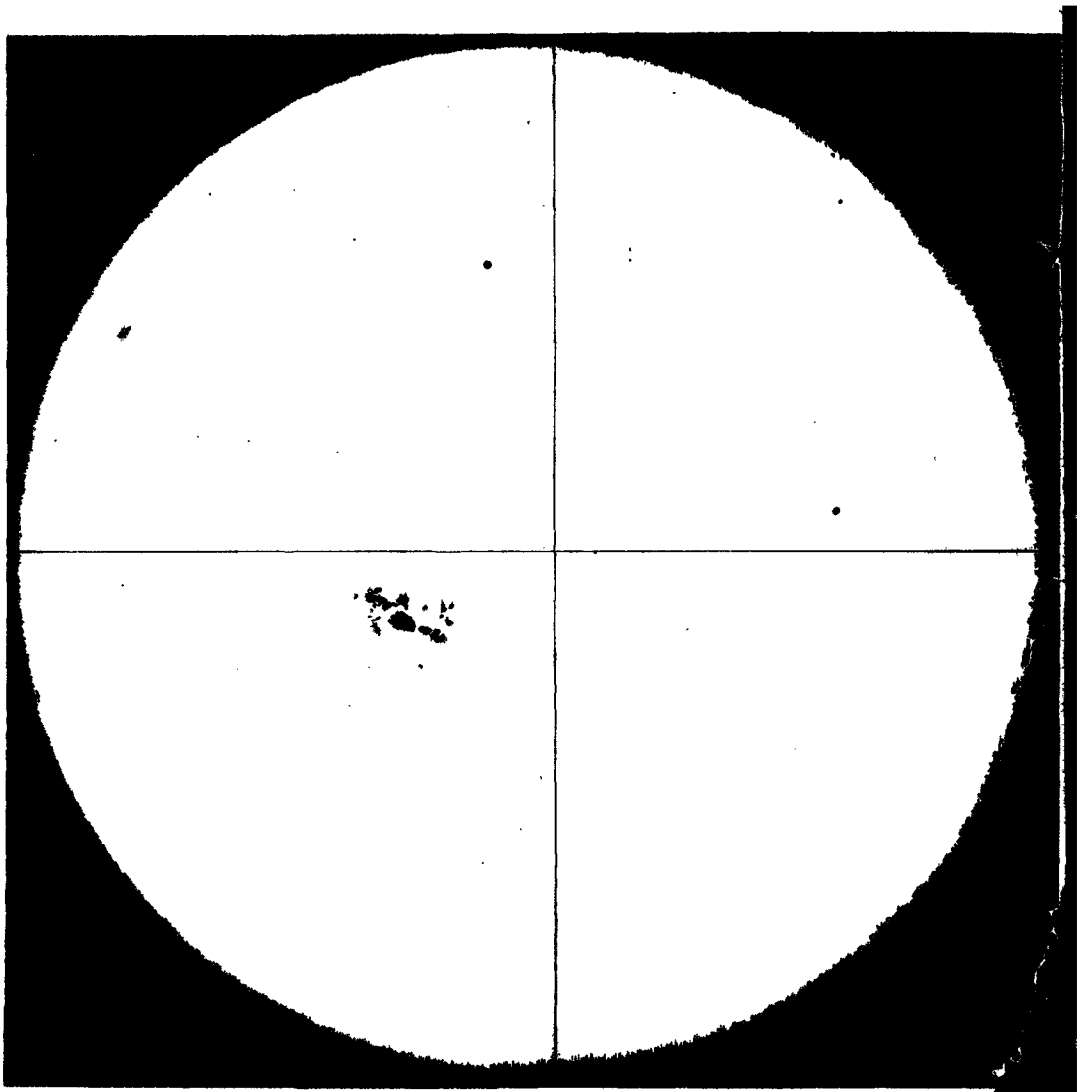
"It is hoped that the next five years may witness greater progress."

Solar Photography.

Photographs of the sun have been taken twice daily, clouds permitting, at Dehra Dún since 1879. Similar photographs have been also taken daily at Greenwich Observatory and

* Average distance in India 39 miles.

PHOTOGRAPH OF THE SUN TAKEN AT DEHRA DUN ON FEBRUARY 3rd 1905.



Photographer.

Survey of India Offices, Calcutta.

THE SUNSPOT IN THE ABOVE PICTURE IS THE LARGEST
THAT HAS BEEN PHOTOGRAPHED AT DEHRA DUN.

Relative size of the Earth ○

at Mauritius. For many years Greenwich, Dehra Dún and Mauritius have acted together under one scheme and on one system. We send our photographs to England weekly to Sir Norman Lockyer, K.C.B., F.R.S., under whose directions we have carried out the work from its inception. In 1898 Sir William Christie, the Astronomer Royal, wrote to the Secretary of State: "The daily photographs of the sun should be continued at Dehra Dún, "where they are being taken satisfactorily under the Surveyor General's direction."*

Note by Lieutenant-Colonel S. G. BURRARD, F.R.S., R.E., on a large Sunspot observed in January 1905.

A photograph of the sun taken at Dehra Dún at 9 A. M. on January 29th, 1905, revealed the existence of a sunspot of exceptional magnitude which was just appearing round the sun's limb.

The spot originated on the further side of the sun from the earth, and it is not, therefore, known whether it attained its full dimensions in a few minutes, or whether its growth continued for several days.

Every point of the surface of a rigid body like the earth, rotates round its polar axis in the same period: but in the case of the sun certain portions of the surface complete a rotation in a shorter period than others. A spot on the sun's equator rotates in 25 days, whilst a spot half way between the equator and the poles takes 27½ days.

It is not easy to measure the exact rotatory period of any particular spot, because spots have proper motions of their own on the sun's surface.

An object near the limb of globe is necessarily foreshortened, but when on January 29th the rotation of the sun brought a new spot into view, it was evident at once that within the preceding fortnight the portion of the sun's surface away from the earth had suffered a disturbance of unusual violence.

As the sun rotated after January 29th, the foreshortening decreased daily; during the first week of February the spot faced the earth and its real dimensions could then be estimated. There is no apparatus in India for measuring the areas of spots, and the sun-photographs are despatched weekly to England. Some idea, however, of the size of the sunspot of February 1905, can be obtained by comparing it with the earth, and for this purpose the earth has been drawn to scale on the plate showing the sunspot. After February 6th, the spot became daily more and more foreshortened, on February 10th, it had reached the sun's further limb, and on February 11th, it had been removed from our view.

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season, 1903-04.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	REMARKS.
			° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
371	Ratagaon (Vijápur).	49/42 8	19 56 40	74 45 50	24 55	E 0 50	0·3685	
372	Aurungábád	39/78 3	19 51 30	75 20 20	24 35	„ 0 50	0·3695	
373	Jálna	„ 4	19 51 50	75 53 00	24 35	„ 1 5	0·3685	
374	Satona	„ 5	19 29 30	76 21 30	23 40	„ 0 55	0·3710	
375	Parbhani	„ 6	19 15 20	76 46 50	23 30	„ 0 55	0·3715	
376	Nander	38/78 1	19 9 30	77 18 10	23 30	„ 0 20	0·3705	
377	Dharmábád (Bálápur).	78/78 1	18 53 10	77 51 30	22 35	„ 0 30	0·3730	
378	Upalwai	„ 2	18 25 10	78 19 20	21 35	„ 0 35	0·3740	
379	Masaipet	„ 3	17 52 40	78 27 30	20 15	„ 0 10	0·3750	
380	Alir	18/80 2	17 38 30	79 2 50	19 50	„ 0 30	0·3770	
381	Warangal	„ 1	17 58 40	79 36 50	22 20	„ 0 25	0·3755	
382	Mánukota	„ 3	17 36 00	80 0 10	19 25	„ 1 10	0·3805	
383	Bona Kalu	„ 4	17 2 00	80 15 50	18 35	„ 0 0	0·3775	
384	Bezwada	18/80 1	16 31 00	80 36 50	17 10	„ 0 0	0·3805	
385	Bapatla	„ 2	15 54 30	80 27 40	16 25	„ 0 35	0·3775	
386	Ongole	„ 3	15 30 20	80 3 20	13 45	„ 2 10	0·3855	
387	Bitragunta	14/80 7	14 48 40	79 57 20	13 40	W 0 35	0·3805	
388	Arambákkam	„ 8	13 32 40	80 4 30	10 50	„ 0 20	0·3820	
389	Acharapákkam	12/80 9	12 24 10	79 49 10	6 50	„ 0 55	0·3780	
341	Villupuram	„ 5	11 56 40	79 29 50	...	E 0 15	...	Declination only re-observed.
390	Eringi	„ 10	11 55 50	79 10 20	5 35	W 0 25	0·3775	
391	Atúr	18/78 10	11 35 40	78 36 50	6 25	„ 0 25	0·3840	
392	Perambalúr	„ 12	11 14 10	78 51 50	5 30	„ 0 35	0·3835	
393	Pudukottái	19/78 4	10 22 50	78 48 50	3 40	„ 0 30	0·3795	

* Report on Indian Observatories.

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season, 1903-04.—contd.

Serial No.	Name of Stations.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
394	Satubara Chattram	19/58 5	10 14 50	79 16 50	2 40	W 0 35	0·3805	
395	Tiruppattúr	„ 11	10 7 10	78 36 00	2 55	„ 0 55	0·3805	
396	Nattam	„ 10	10 13 40	78 14 00	3 0	„ 0 40	0·3790	
397	Palmanér	14/78 14	13 12 20	78 44 50	9 45	„ 0 25	0·3805	
398	Madanapalle	„ 19	13 34 40	78 30 30	10 35	„ 0 15	0·3810	
399	Páragada	„ 12	14 6 20	77 17 10	12 0	E 0 0	0·3795	
400	Kalyándrug	„ 11	14 32 50	77 0 40	13 15	W 0 20	0·3765	
401	Hangal	14/78 6	14 44 10	76 41 50	13 5	„ 0 5	0·3785	
402	Chalakere	„ 8	14 19 00	76 39 00	12 20	„ 0 5	0·3795	
403	Hiriyúr	„ 10	13 56 30	76 36 40	11 25	„ 0 5	0·3790	
1	Pavdásán	14/58 3	24 29 20	71 53 50	33 45	E 1 10	0·3520	Re-observed.
2	Sáchor	„ 2	24 45 20	71 45 50	33 55	„ 1 40	0·3520	do.
3	Dutwa	„ 1	24 52 50	71 28 50	34 0	„ 2 0	0·3495	do.
4(*a*)	Sheria Bheel (*a*)	15/78 1	24 43 50	70 52 50	33 25	„ 1 45	0·3500	do.
5	Tur Loonian	„ 2	24 39 00	70 31 40	34 5	„ 2 15	0·3505	do.
6(*a*)	Islámkot (*a*)	„ 3	24 42 10	70 9 50	33 35	„ 1 20	0·3545	do.
7(*a*)	Dipla (*a*)	„ 4	24 28 00	69 34 30	33 25	„ 2 0	0·3480	do.
8	Rahím-ki-Bazár	„ 5	24 19 00	69 9 00	32 55	„ 1 50	0·3495	do.
9	Kirria	13/58 3	24 20 00	68 46 40	32 45	„ 1 40	0·3500	do.
10(*a*)	Lachpat (*a*)	„ 4	23 49 20	68 46 20	31 55	„ 1 45	0·3510	do.
11(*a*)	Murr (*a*)	„ 5	23 33 20	68 56 40	31 45	„ 2 0	0·3520	do.
12(*a*)	Nakhtrana (*a*)	14/78 6	23 20 50	69 15 10	31 30	„ 1 35	0·3525	do.
13	Kalyánpur	„ 8	23 13 40	69 35 40	30 55	„ 1 15	0·3555	do.
14	Bhímasar	„ 9	23 11 20	70 9 50	30 30	„ 1 5	0·3525	do.
15(*a*)	Lákadiya (*a*)	„ 7	23 20 30	70 34 40	31 30	„ 1 5	0·3510	do.
16(*a*)	Adesar (*a*)	„ 10	23 33 30	70 59 10	31 35	„ 1 15	0·3545	do.
17	Várábi	14/58 10	23 47 50	71 26 20	31 55	„ 1 25	0·3545	do.
18	Diodar	„ 7	24 6 30	71 46 10	32 25	„ 1 30	0·3550	do.
404	Lohana (Jaswant-pura).	„ 14	24 47 20	72 27 10	33 40	„ 1 35	0·3540	
405	Jálor	14/58 12	25 21 10	72 36 50	34 40	„ 1 20	0·3500	
406	Mandaula G. T. S.	„ 11	25 24 50	71 52 10	35 5	„ 2 0	0·3515	
407	Wallar	„ 9	26 29 10	71 48 40	39 55	„ 2 20	0·3470	
408	Mandai, G.T.S.	„ 10	26 21 10	71 10 40	36 20	„ 1 50	0·3460	
409	Jejrawa	15/78 13	26 15 20	70 38 50	36 15	„ 2 0	0·3445	
410	Ráviláhu, G.T.S.	„ 12	26 52 40	70 2 20	37 25	„ 2 10	0·3425	
411	Khubba	„ 11	26 49 10	70 40 10	37 25	„ 2 10	0·3425	
412	Kakrasar	14/58 8	26 55 40	71 12 10	37 35	„ 2 25	0·3430	
413	Hardikot, G.T.S.	„ 7	26 57 30	71 51 00	38 35	„ 3 5	0·3390	
414	Satiaya	14/78 14	27 25 20	71 39 10	38 15	„ 2 40	0·3380	
415	Deega	„ 15	27 24 20	71 0 0	38 25	„ 2 20	0·3400	
410	Kolu, G.T.S.	13/78 14	27 25 10	70 17 30	38 25	„ 2 10	0·3405	
26	Reti	„ 3	28 5 10	69 51 20	39 25	„ 2 40	0·3365	Re-observed.
54(*a*)	Sibi (*a*)	10/58 1	29 32 40	67 51 40	41 50	„ 2 45	0·3275	do.
417	Lehri	„ 11	29 10 40	68 12 40	41 15	„ 2 20	0·3300	
418	Chirdi Dhabbar	„ 12	29 5 20	68 43 10	40 55	„ 2 25	0·3310	
419	Derah Bugtí	15/78 15	29 2 00	69 9 20	40 50	„ 2 35	0·3315	
420	Chat	„ 14	29 20 20	69 24 30	41 25	„ 2 40	0·3305	
421	Mat	„ 13	29 42 20	69 40 00	41 55	„ 2 50	0·3290	
422	Rakni	„ 12	30 2 50	69 55 30	42 25	„ 3 0	0·3285	
423	Kingri	„ 11	30 26 20	69 49 00	43 5	„ 3 5	0·3265	
424	Músa-Khel Bazár	„ 9	30 52 30	69 48 50	43 45	„ 3 10	0·3245	
425	Mekhtar	„ 10	30 29 00	69 20 20	43 5	„ 2 55	0·3260	
426	Fort Sandeman	15/58 7	31 20 40	69 27 10	44 25	„ 3 15	0·3220	
427	Musáfirpur	14/58 8	30 58 00	69 8 30	43 50	„ 3 0	0·3240	
428	Kalu Killa	10/58 7	30 41 40	68 43 20	43 25	„ 2 55	0·3250	
429	Killa Saifulla	„ 6	30 42 50	68 21 10	43 25	„ 3 5	0·3240	
430	Hindu Bagh	„ 5	30 49 20	67 44 30	43 40	„ 3 0	0·3220	
431	Chinjan	„ 8	30 34 10	67 55 50	43 0	„ 3 0	0·3240	
432	Loralai	„ 9	30 21 30	68 36 30	42 55	„ 2 50	0·3255	
433	Puzza	„ 10	29 54 00	68 42 40	42 15	„ 2 45	0·3275	
434	Ferozepore	10/78 12	30 57 50	74 36 10	44 30	„ 2 30	0·3250	
435	Moga	10/58 14	30 49 40	75 10 30	44 0	„ 2 55	0·3295	
69	Ladhowál	„ 1	30 59 00	75 47 20	44 20	„ 2 55	0·3290	Re-observed
436	Mahábaleshvar	12/78 7	17 55 50	73 39 40	20 35	„ 0 5	0·3680	
437	Helwák	„ 8	17 22 20	73 43 10	19 5	„ 0 40	0·3715	
438	Amba	14/78 7	16 58 20	73 47 50	19 10	„ 0 20	0·3715	
439	Dájeepur	„ 8	16 22 40	73 52 40	17 30	„ 0 5	0·3755	
440	Rámghat	„ 9	15 49 40	74 6 20	15 45	„ 0 35	0·3660	
441	Yellápur	14/78 1	14 57 40	74 42 30	13 55	W 0 5	0·3765	
442	Banvási	12/78 7	14 32 20	75 1 10	13 5	„ 0 5	0·3770	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season, 1903-04.—contd.

Serial No.	Name of station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C. G. S.	
443	Mauvinhola	14/15 9	13 59 10	75 6 20	11 45	W 0 5	0·3775	
444	Koppa	„ 11	13 31 50	75 19 30	10 35	„ 0 25	0·3785	
445	Beltángády	13/15 8	12 59 10	75 17 00	9 40	„ 0 25	0·3780	
446	Sullia	„ 12	12 34 20	75 23 20	8 40	„ 0 15	0·3770	
447	Sáklespur	„ 9	12 56 40	75 47 30	9 15	„ 0 20	0·3790	
448	Dándigánhálli	„ 10	12 58 20	76 16 50	9 10	„ 0 15	0·3785	
449	Vediyur	„ 11	12 58 40	76 51 20	9 15	„ 0 15	0·3795	
450	Singánallúr	11/15 8	12 8,30	77 13 00	7 50	„ 0 15	0·3825	
451	Kávéripur	„ 9	11 54 20	77 45 30	7 45	„ 0 25	0·3790	
452	Satyamangalam	„ 11	11 30 00	77 14 20	6 15	„ 0 25	0·3835	
453	Gundlupet	12/15 13	11 48 20	76 41 20	6 40	„ 0 30	0·3810	
454	Sultan's Battery	„ 14	11 39 40	76 15 30	6 25	„ 0 30	0·3815	
455	Ootacamund	„ 15	11 24 30	76 42 50	5 45	„ 0 30	0·3805	
456	Nilambúr	„ 16	11 16 20	76 13 20	5 25	„ 0 30	0·3785	
457	Anamalais	10/15 3	10 34 50	76 56 00	4 5	„ 0 45	0·3805	
458	Dhárápuram	10/15 8	10 43 30	77 31 20	4 30	„ 0 50	0·3840	
459	Periyakulam	„ 9	10 7 40	77 33 20	3 0	„ 1 10	0·3835	
460	Top Station (Kanan Devan hills).	„ 12	10 6 40	77 13 20	3 50	„ 0 10	0·3795	
461	Munnar	„ 12	10 4 10	77 3 20	3 5	„ 0 35	0·3805	
462	Nyamakad Estate (Kanan Devan hills).	„ 12	10 8 10	77 3 10	3 0	„ 0 40	0·3810	
463	Kuravanath	„ 13	9 38 50	77 12 30	2 0	„ 1 0	0·3815	
464	Kanjarapalli	10/15 8	9 33 00	76 46 50	1 25	„ 1 0.	0·3780	
465	Alleppi	„ 7	9 29 50	76 19 10	0 30	„ 1 0.	0·3745	
466	Quilon	9/15 2	8 53 30	76 36 00	—0 25	E 0 10	0·3780	South end of needle dipping.
467	Punalur	10/15 9	9 1 20	76 55 30	0 45	W 1 0	0·3795	
468	Tenkási	8/15 6	8 58 00	77 18 30	0 35	„ 1 0.	0·3805	
469	Virudupatti	10/15 14	9 35 50	77 57 40	0 45	„ 1 10	0·3835	
470	Manapád	7/15 3	8 22 20	78 4 00	—1 0	„ 1 5.	0·3800	Do.
471	Nágarkoil	„ 5	8 11 20	77 26 00	—1 25	„ 1 5	0·3785	Do.
472	Trivandrum	„ 4	8 28 50	76 55 30	—0 30	„ 0 50.	0·3800	Do.
473	Cochin	10/15 5	9 57 50	76 14 00	2 55	„ 0 35	0·3810	
474	Kodhamangalam	„ 6	10 3 40	76 37 40	2 40	„ 1 0.	0·3775	
475	Irinjalakuda	„ 4	10 20 20	76 13 00	4 5	„ 0 55	0·3790	
476	Lucknow	16/15 2	26 50 00	80 55 20	37 45	E 1 55	0·3510	Visited by two observers.
477	Rae-Bareli	16/15 3	26 14 00	81 14 40	36 25	„ 1 45	0·3550	
478	Amethi	„ 5	26 9 20	81 48 40	36 50	„ 1 55.	0·3540	
479	Suriawán	„ 8	25 28 00	82 25 50	35 15	„ 1 50	0·3585	
480	Chunár	„ 10	25 6 10	82 52 30	34 40	„ 1 35	0·3600	
481	Allahabad	„ 7	25 27 30	81 49 20	35 3	„ 1 40.	0·3585	
482	Kunwar	„ 6	25 42 00	81 13 10	35 45	„ 1 50	0·3530	
483	Mánikpur	„ 9	25 3 10	81 5 20	34 30	„ 1 35	0·3590	Visited by two observers.
484	Karmnása	14/15 11	25 14 30	83 25 20	35 0	„ 1 40.	0·3590	
485	Japla	14/15 2	24 32 30	84 0 00	34 5	„ 1 10	0·3645	
486	Daltonganj	„ 3	24 2 00	84 4 30	32 30	„ 1 35	0·3665	
487	Palmerganj	„ 1	24 51 40	84 19 50	34 35	„ 1 25	0·3695	
488	Nawádah	14/15 1	24 52 30	85 32 50	34 10	„ 1 30	0·3645	
489	Monghyr	16/15 8	25 23 10	86 27 50	35 10	„ 1 40	0·3620	
490	Bhágalpur	„ 9	25 14 00	86 57 40	35 5	„ 1 25	0·3625	
491	Sáhebganj	14/15 2	25 14 50	87 38 20	34 55	„ 1 30	0·3650	
492	Pakaur	14/15 1	24 38 50	87 51 40	33 50	„ 1 25	0·3640	
493	Azimganj	„ 2	24 14 10	88 15 10	33 15	„ 1 20	0·3685	
494	Sainthia	„ 3	23 56 50	87 41 20	32 40	„ 1 15	0·3670	
495	Burdwan	„ 5	23 15 00	87 52 40	31 15	„ 1 15	0·3700	
496	Calcutta	13/15 3	22 33 40	88 17 30	29 55	„ 1 20	0·3725	
497	Ulubaria	„ 4	22 28 20	88 6 20	29 40	„ 1 5	0·3730	
498	Midnapore	„ 2	22 25 20	87 17 30	29 50	„ 1 10	0·3730	
499	Ghátsila	12/15 2	22 35 00	86 28 20	30 10	„ 1 20	0·3705	
500	Sini	„ 1	22 47 00	85 56 50	30 5	„ 1 20	0·3725	
501	Purulia	14/15 6	23 19 30	86 22 50	31 15	„ 1 30	0·3725	
502	Bankura	13/15 6	23 13 30	87 4 10	31 20	„ 1 30	0·3710	
503	Garhbeta	13/15 1	22 50 40	87 18 50	31 5	„ 0 55	0·3710	
504	Rániganj	14/15 4	23 35 30	87 7 30	31 40	„ 1 25	0·3700	
505	Kátrásgarh	14/15 5	23 48 00	86 18 00	32 15	„ 1 25	0·3675	
506	Giridíh	„ 4	24 10 50	86 19 20	32 50	„ 1 25	0·3660	
507	Baidyanáth	„ 3	24 30 50	86 38 00	33 35	„ 1 35	0·3655	
508	Gidhaur	„ 2	24 52 20	86 18 00	34 15	„ 1 35	0·3640	
509	Barh	15/15 7	25 28 20	85 42 50	35 40	„ 1 45	0·3605	
510	Patna	„ 5	25 35 30	85 12 20	35 30	„ 1 35	0·3595	
511	Jahánabad	„ 6	25 13 40	84 59 50	34 55	„ 1 35	0·3615	
512	Buxar	14/15 10	25 33 30	83 57 40	35 30	„ 3 35	0·3630	
513	Malipur	15/15 4	26 16 10	82 38 50	36 40	„ 1 50	0·3560	
514	Daryábád	„ 2	26 51 30	81 33 00	37 50	„ 2 0	0·3520	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season, 1903-04—contd.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C. G. S.	
515	Gonda	4	27 8 30	81 58 20	38 25	E 2 0	0·3505	
516	Tulsipur	3	27 31 30	82 24 40	38 55	„ 2 10	0·3495	
517	Nánpára	2	27 51 40	81 31 10	39 20	„ 2 15	0·3485	
518	Katarnian Ghát	1	28 19 50	81 7 50	40 10	„ 2 20	0·3460	
519	Basti	1	26 49 10	82 46 30	37 50	„ 1 55	0·3535	
520	Gorakhpur	1	26 45 00	83 23 20	37 40	„ 1 50	0·3540	
521	Uska-Bazár	1	27 11 30	83 6 20	38 35	„ 2 0	0·3510	
522	Bhatni	3	26 23 00	83 55 40	36 55	„ 1 50	0·3555	
523	Mau	7	25 56 20	83 34 20	36 20	„ 1 55	0·3550	
524	Azamgarh	6	26 1 50	83 11 10	36 15	„ 1 50	0·3565	
525	Aunrihar	9	25 32 10	83 9 50	35 40	„ 1 45	0·3580	
526	Siwán	5	26 12 30	84 20 40	36 40	„ 1 45	0·3565	
527	Chapra	8	25 48 10	84 43 20	36 20	„ 0 45	0·3595	
528	Muzaffarpur	4	26 6 30	85 22 30	36 35	„ 1 50	0·3590	
529	Pipra	4	26 29 30	84 59 10	37 20	„ 2 15	0·3565	
530	Bettiah	2	26 48 50	84 31 30	37 45	„ 2 0	0·3545	
531	Bairagnia	1	26 43 50	85 16 30	38 0	„ 1 55	0·3540	
532	Khanwa Ghát	1	26 22 10	87 3 20	37 10	„ 1 30	0·3570	
533	Nirmali	2	26 18 00	86 34 00	36 55	„ 1 55	0·3575	
534	Darbhanga	3	26 6 00	85 54 20	36 50	„ 1 45	0·3565	
535	Gwalior	3	26 12 50	78 11 00	36 35	„ 2 10	0·3505	
536	Mahona	4	25 53 40	77 46 40	35 40	„ 1 45	0·3535	
537	Sipri	6	25 26 00	77 39 20	35 15	„ 1 35	0·3520	
538	Bhind	2	26 34 10	78 47 50	38 0	„ 1 15	0·3480	
539	Datia	5	25 38 40	78 27 30	35 0	„ 1 20	0·3525	
540	Basai	7	25 8 40	78 23 30	35 0	„ 1 20	0·3530	
541	Lalitpur	1	24 40 50	78 24 10	33 50	„ 1 30	0·3600	
541(*a*)	Lalitpur (*a*)	1	24 41 10	78 25 50	34 0	„ 1 30	0·3590	
542	Pachhár	2	24 34 50	77 43 40	33 45	„ 1 20	0·3565	
543	Dharnáoda	3	24 35 50	77 5 50	34 0	„ 1 45	0·3545	
544	Bárán	5	25 5 30	76 30 30	34 45	„ 1 35	0·3530	
545	Bína	4	24 10 50	78 11 00	32 25	„ 1 20	0·3610	
546	Bhilsa	6	23 31 10	77 48 50	32 30	„ 2 30	0·3560	
547	Bhopal	7	23 15 50	77 24 30	31 25	„ 1 20	0·3605	
548	Hoshangabad	1	22 45 10	77 43 00	30 15	„ 1 10	0·3635	
549	Pagdhál	4	22 24 50	77 21 10	29 50	„ 1 15	0·3625	
550	Pipláni	3	22 7 10	76 47 30	30 0	„ 1 40	0·3585	
551	Khandwa	4	21 49 20	76 21 50	29 10	„ 0 45	0·3605	
552	Burhánpur	5	21 20 10	76 11 40	27 20	„ 1 5	0·3660	
553	Sindkheda	10	21 14 10	74 44 20	26 50	„ 0 55	0·3670	
554	Nandurbár	9	21 22 30	77 14 40	27 45	„ 1 0	0·3625	
555	Jalgaon	2	21 1 20	75 33 40	26 45	„ 0 50	0·3650	
556	Barwaha	2	22 15 20	76 1 30	29 5	„ 1 5	0·3640	
557	Indore	1	22 42 10	75 52 40	30 0	„ 1 10	0·3655	
558	Barnagar	6	23 3 50	75 22 30	31 15	„ 1 25	0·3595	
559	Tarána Road	4	23 15 40	76 3 50	31 10	„ 1 25	0·3580	
560	Shujáulpur	5	23 23 00	76 43 40	32 5	„ 1 50	0·3595	
561	Sohágpur	3	22 41 30	78 11 20	29 15	„ 1 15	0·3625	
562	Mohpáni	2	22 44 40	78 50 20	30 5	„ 1 15	0·3650	
563	Narsinghpur	1	22 56 50	79 12 30	30 35	„ 1 30	0·3635	
564	Mirganj	6	23 9 40	79 46 50	31 30	„ 1 20	0·3580	
565	Sleemanábád	5	23 36 30	80 16 20	31 45	„ 1 10	0·3065	
566	Salaiya	4	23 51 10	79 58 20	...	„ 1 30	0·3620	No dip observed.
567	Damoh	3	23 50 00	79 26 00	32 30	„ 1 25	0·3600	
568	Saugor	4	23 50 50	78 44 20	32 15	„ 1 50	0·3615	
569	Dholpur	1	26 41 50	77 54 20	37 35	„ 1 50	0·3495	
570	Agra Cant.	9	27 10 40	78 0 20	38 10	„ 2 0	0·3470	
571	Shikohabad	10	27 4 30	78 35 30	38 5	„ 2 10	0·3485	
572	Achalda	3	26 41 50	79 24 50	37 30	„ 2 0	0·3510	
573	Cawnpore	4	26 27 00	80 21 00	36 55	„ 2 0	0·3535	
574	Kálpi	5	26 7 00	79 45 50	36 20	„ 1 50	0·3540	
575	Púnch	7	25 49 00	79 2 50	35 50	„ 1 40	0·3535	
576	Mau Ránípur	8	25 15 10	79 9 10	35 0	„ 1 35	0·3555	
577	Mahoba	9	25 18 10	79 50 40	35 0	„ 1 50	0·3545	
578	Atarra	10	25 17 20	80 34 10	35 5	„ 1 40	0·3565	
579	Sutna	1	24 34 20	80 50 00	33 55	„ 1 40	0·3600	
580	Amdara	2	24 6 10	80 34 40	32 45	„ 1 20	0·3620	
581	Málwa	6	26 0 50	80 40 00	36 10	„ 1 45	0·3535	
582	Araul	1	26 55 00	80 1 40	37 55	„ 1 55	0·3510	
583	Farukhábád	11	27 23 10	79 34 40	38 40	„ 2 5	0·3475	
584	Ganj Dundwára	8	27 43 30	78 56 20	39 10	„ 2 15	0·3460	
585	Kherli	8	27 12 10	77 1 30	38 10	„ 2 10	0·3465	
586	Aligarh	7	27 53 40	78 4 20	39 20	„ 2 10	0·3450	
587	Dhanári	6	28 19 50	78 30 20	40 0	„ 2 10	0·3435	
588	Aonla	6	28 17 50	79 10 10	40 0	„ 2 20	0·3440	
589	Miránpur Katra	5	28 2 20	79 40 20	39 45	„ 2 10	0·3450	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season, 1903-04—concld.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	′ ″ °	° ′	° ′	C. G. S.	
590	Anjhi	$\frac{38}{80}$ 9	27 38 20	79 59 20	39 0	E 2 5	0·3475	
591	Sanoda	,, 12	27 7 00	80 25 10	38 10	,, 2 0	0·3495	
592	Kamalpur	,, 10	27 22 30	80 49 40	38 35	,, 2 0	0·3490	
593	Lakhimpur	,, 7	27 56 20	80 46 20	39 30	,, 2 10	0·3460	
594	Chandan Chauki	,, 3	28 32 20	80 46 40	40 30	,, 2 20	0·3450	
595	Khutár	,, 4	28 12 00	80 15 40	40 0	,, 2 10	0·3450	
596	Sháhgarh	,, 2	28 33 30	80 3 10	40 30	,, 2 20	0·3435	
597	Richha Road	,, 1	28 43 00	79 29 30	40 45	,, 2 20	0·3430	
598	Káthgodám	$\frac{20}{10}$ 1	29 15 20	79 32 50	41 40	,, 2 30	0·3390	
599	Garhmuktesar	$\frac{36}{18}$ 4	28 46 40	78 4 00	40 55	,, 2 30	0·3410	
600	Chola	,, 5	28 18 30	77 43 40	40 15	,, 2 20	0·3420	
601	Moradabad	,, 3	28 50 00	78 45 30	41 0	,, 2 25	0·3415	
602	Nagina	$\frac{10}{11}$ 10	29 25 50	78 25 00	41 55	,, 2 35	0·3380	
	Repeat stations.							
I	Udaipur		24 35 33	73 41 57	33 25	E 1 30	0·3535	
II	Karachi		24 49 50	67 2 2	33 40	,, 1 0	0·3470	
III	Quetta		30 11 52	67 0 20	42 45	,, 2 55	0·3245	
IV	Bahâwalpur		29 23 27	71 40 37	41 40	,, 2 50	0·3330	
V	Ráwalpindi		33 35 16	73 3 6	47 55	,, 3 40	0·3135	
VI	Bharatpur		27 13 31	77 29 28	38 20	,, 2 05	0·3465	
VII	Bangalore		12 59 35	77 35 58	9 25	W 0 25	0·3815	
VIII	Dhárwár		15 27 26	74 59 35	15 0	E 0 0	0·3765	
IX	Porbandar		21 38 20	69 37 6	28 20	,, 1 15	0·3610	
X	Fyzabad		26 47 27	82 7 40	37 35	,, 1 55	0·3535	
XI	Sambalpur		21 28 3	83 58 26	27 35	,, 1 05	0·3720	
XII	Waltair		17 42 54	83 19 1	20 55	,, 0 30	0·3775	
XIII	Darjeeling		26 59 49	88 16 39	...	,, 1 50	0·3565	No dip observed.
XIV	Gaya		24 46 30	84 58 54	34 0	,, 1 25	0·3660	
XV	Secunderábád		17 27 11	78 29 16	19 50	,, 0 40	0·3790	
XVI	Bhusával		21 2 46	75 47 18	26 35	,, 1 0	0·3685	
XVII	Jubbulpore		23 8 57	79 56 44	30 40	,, 1 15	0·3650	

Note.—The above values of Dip Declination, and Horizontal Force are uncorrected for secular change, diurnal variation, instrumental differences, etc., and are to be considered as preliminary values only.

Where blanks occur, values have been already found during previous field seasons, or the observations have not been completed.

The Survey numbers refer to the published chart: thus No. $\frac{38}{80}$ 3 denotes No. 3 Station in the dotted square, the spherical co-ordinates of whose centre are 26° North Latitude and 76° East Longitude.

All Longitudes are referable to that of Madras Observatory taken at the value 80° 14′ 47″ East from Greenwich.

G. I. C. P. O.—No. 493 S. G.—19-10-05.—450.—G. A.

Photogravure. Survey of India Offices, Calcutta, May 1906.

J. R. Hobday.

From a photograph by Messrs Johnston & Hoffmann.

Photogravure. Survey of India Offices, Calcutta. August 1905.

RAI BAHADUR KISHEN SINGH MILAMWAL.

SURVEY OF INDIA.

THE "A-K" OF TIBETAN EXPLORATION

1869-83.

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1904-05.

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BAY of BENGAL
INDEX CHART
TO THE
GREAT TRIGONOMETRICAL SURVEY
OF
INDIA
CEYLON

INDIA
To 1st October 1905
REFERENCE TO COLOURS
BAY OF BENGAL
INDIAN OCEAN
Reg. No. 998-S. 06.

GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1904-1905.

PART I.

SUMMARY.

ADMINISTRATION.

1. This report deals with the operations of the Department for the survey year ending the 30th of September 1905. The general administration remained in the hands of Lieutenant-Colonel F. B. Longe, R.E., until the 9th November 1904, when he was placed on special duty as a member of the Indian Survey Committee and was temporarily replaced as Surveyor General by Colonel J. R. Hobday, I.A., until the close of the Committee's deliberations on the 3rd of May 1905 when he again resumed his substantive appointment of Surveyor General. The office of Deputy Surveyor General was held by Colonel J. R. Hobday, I.A., until he relieved Lieutenant-Colonel Longe, R.E., as Surveyor General and again from the 4th of May until the 15th July 1905 when he retired from the Department on superannuation. In his place, Colonel R. A. Wahab, C.B., C.M.G., C.I.E., was appointed Deputy Surveyor General, but as he was on leave and unable to take up the appointment, Lieutenant-Colonel G. B. Hodgson, I.A., was appointed to officiate for him and on Colonel Wahab's retirement from the service on the 31st of August 1905, Colonel Hodgson's appointment was confirmed. Colonel Hodgson also officiated as Deputy Surveyor General while Colonel J. R. Hobday, I.A., officiated as Surveyor General. Lieutenant-Colonel S. G. Burrard, F.R.S., R.E., retained his appointment of Superintendent, Trigonometrical Surveys, throughout the year, and Major C. W. H. Symonds, I.A., held the office of Superintendent, Forest Surveys, until the 3rd of November 1904 when he was relieved by Major P. J. Gordon, I.A., the permanent incumbent, on his return from furlough.

2. This year will be memorable in the history of the Department on account of the appointment by the Government of India of a Committee to consider (1) the state of the maps in each province and the measures required to bring them up to date; (2) methods and expense of survey; (3) methods of reproduction; and (4) the organisation of the Department.

The Committee was composed as follows:—

President.

Mr. J. O. Miller, C.S.I., I.C.S.

Members.

Colonel Sir John Farquharson, K.C.B., (late) R.E. and a former Director General of Ordnance Surveys.

Colonel F. H. Kelly, (late) R.E.

Lieutenant-Colonel F. B. Longe, R.E., Surveyor General of India.

Mr. C. A. Barron, I.C.S. (Secretary).

In addition to these officers, Colonel S. C. N. Grant, C.M.G., R.E., of the Ordnance Survey of Great Britain was specially deputed from England to examine the existing methods of reproduction in the Photo-Litho. offices at Calcutta and Dehra Dún and to advise the Committee as to future organisation and methods of reproduction.

As a full report of the proceedings and recommendations of the Committee has been published separately and is available for reference by such as are interested in it, it is unnecessary to do more than give a brief account of its proceedings and recommendations.

3. The Committee assembled in Calcutta in the latter half of November 1904 and finally dispersed in the end of April 1905. Colonel Grant's enquiries were made during the months of January and February and the period allowed for them was insufficient to enable him to draw up any definite scheme for the re-organisation of the Drawing and Reproducing offices, though his report will be of great value to such officers as may be appointed later to prepare such a scheme and to arrange for the future execution of the extra-departmental work now carried out in those offices which has been found in the past to seriously interfere with the regular work of the Department.

4. The Committee spent the latter part of November, parts of December and January and greater part of March on tour, visiting Gauháti and Shillong in Assam; Káthiár and Dinapore in Bihár; Rangoon, Toungoo, Mandalay, Maymyo and Katha in Burma; Madras, Bangalore, Poona, Bombay and Badnera in Berar; Lucknow, Dehra Dún and Rájpur in the United Provinces; Lahore in the Punjab and Peshawar in the North-West Frontier Province. The President and Colonel Longe also visited Hyderabad, and the President paid a short visit to Roorkee. Time did not allow of further touring as it was necessary to complete the report by the end of April.

5. A mass of evidence was taken and recorded and the existing maps of practically the whole of India were examined in Calcutta with the result that it was found that while these maps were undoubtedly good at the time they were made, and their accuracy as far as they went was unquestionable, they were published in an inconvenient size and they were not up to modern standards in quality of reproduction; that they had not been prepared on any one uniform system, nor were they necessarily complete to margin; that the symbols used on them were not uniform and they were deficient in heights and levels. Besides which, in many parts of India, they were so out of date as to be of little use and in some cases even misleading owing to the changes in roads, etc., since they were prepared.

6. The Committee recommended the preparation of a series of maps of half the present standard sheet size on the scale 1-inch=1 mile to cover the whole of India, which should be reproduced in colours. It stipulated that a far greater number of heights and levels should be shewn, that one system of symbols should be employed throughout the whole series and that a selection of these symbols should be published on every map. The Committee further laid down that the surveys should in future, as a rule, be made on the scale of 2-inches=1 mile for reduction and publication on the 1-inch scale.

7. In order to carry out these decisions it will be necessary to revise in the field practically the whole of the existing one-inch maps of India and to survey on either the two or the one-inch scale the whole of the country for which maps on neither of those scales have ever yet been prepared.

The class of revision was gone into as carefully as the very limited time at the disposal of the Committee permitted and omitting the Baluchistan Agency and the tribal area of the North-West Frontier Provinces it is estimated that an area of 525,800 square miles of original survey will have to be made, that a practical re-survey will have to be made of 479,000 square miles, while the maps of 266,300 square miles may be capable of revision in the field, such revision being, it is hoped, merely the addition of new roads, rail roads, etc., the insertion of additional heights and correction of the contouring.

Taking the total area excluding Baluchistan and North-West Frontier tribal areas as 1,673,300 square miles, there remains an area of 266,300 square miles for which cadastral maps are or will be available from which to prepare topographical maps with inconsiderable corrections in the field and 135,900 square

miles, chiefly in Burma, for which the maps are modern and merely require redrawing.

8. It is proposed that the whole of this work should be carried out within 25 years while the survey of Baluchistan, North-West Frontier Province and the country adjacent thereto should be completed within a much shorter period.

9. The Committee further recommended that cadastral operations should be left entirely under the control of Provincial Governments and local authorities and conducted at their expense, but that the Survey of India should lend for the execution of such surveys such Imperial and Provincial officers as local Governments might from time to time require, such officers being invariably seconded in the Survey of India. It further recommended that the Survey of India should no longer be called upon to execute special forest surveys on scales larger than 2-inches=1 mile in any but exceptional cases, and that where such surveys were executed the cost should be debited to the Forest Department, and further that in future village boundaries should not be shewn on ordinary topographical maps, but that if local governments desired to have maps showing village boundaries special editions should be published for their benefit under certain conditions. It also recommended the abolition of the engraved atlas sheet series commonly known as the Atlas of India, on account of the antiquity of most of the information shewn thereon and the substitution for it of a series of engraved maps on the scale 1-inch=4 miles, each map covering one degree of latitude by one degree of longitude and that this series should be called the "degree sheet" series. It will be readily understood that these proposals involve an enormous amount of work and will, if approved, necessitate a large increase in the staff of the Department and a very careful re-organisation.

10. Perhaps the most important recommendation of the Committee is that a definite programme should be laid down for India as a whole and that this programme should not be departed from without grave reason and then only under the orders of the Government of India. One of the main reasons for the want of uniformity in the topographical maps of the past is to be found in the fact that no such programme has ever been attempted, but surveys have been carried out from time to time by provinces, states or even districts, regardless of the scale or quality of the maps of the country adjacent thereto. The dates of such surveys vary enormously. They were carried out under the orders of a great number of Surveyor Generals and under many different systems. From an artistic point of view many of the older maps are better than those of later years, but in former days, the actual topography and fair mapping were executed almost entirely by highly trained Provincial officers and the triangulation was generally the work of Imperial officers, while for the last 20 years or more the policy of making greater use of native agency and thereby reducing the cost of surveys and increasing the outturn, has undoubtedly caused deterioration in the class of work done in the Department and the necessity for economy has led to the employment of cheap and in many cases unsatisfactory workmen, but with the enormous areas to be dealt with in the immediate future, it will seem impossible to change the system at the present time, though every endeavour will be made to secure the services of a superior class of native for the subordinate grades.

11. The enormous extent of our Indian possession, the lack of communications and the distances between the various field parties, have in the past rendered it practically impossible for Surveyor Generals or Deputy Surveyor Generals to inspect the various parties in the field and to check the methods of their subordinate officers and the style in which the work of any one party has been carried out has been therefore more dependent on the idiosyncrasies of the officers in charge at the time than on any general principle.

The policy of the Committee therefore in suggesting that the Government of India should lay down a definite programme for the future and should formulate certain rules as to the maps that should be prepared, the scales on which surveys should be made, and the style in which maps should be drawn and reproduced, is therefore a subject of great importance and one that should be welcomed by the Department.

12. The Committee estimate that it will require 15 parties of the following strength to carry out their recommendations within a period of 25 years, *viz.*, 2 Imperial officers, 5 to 7 Provincial officers, 32 Surveyors and a proportion of writers, etc. Each party will have to deal yearly with an area of nearly 4,500

square miles and if the work is to be of high standard, the surveyors employed on it will have to be most highly trained, while the officers will require to exert all their energies in superintending the work in the field and recess.

13. If it is conceded that the Surveyor General in past times has been unable to exercise the supervision that is necessary to ensure uniformity it is obvious that with such a large increase in the yearly outturn and with 15 parties scattered all over India it would be still more impossible for him to exercise efficient control without material assistance and it is to be hoped that this assistance will be afforded to him by the creation of at least 4 Superintendents of Circles, each being charged (under the general superintendence of the Surveyor General) with the control of the parties working within the areas assigned to his circle.

14. As an outcome of the Committee's deliberations, and more especially in compliance with the request of the military authorities, the old system of numbering standard sheets by provinces will be discontinued and one series of numbers will in future be employed for the whole of the maps of India and adjacent countries.

Owing to the reduction in the size and shape of the 1-inch standard sheets and to the abolition of the atlas sheets series and substitution for it of the degree sheets series this is rendered a comparatively easy matter, for 16 1-inch standard sheets will in future make up exactly one degree sheet, while 16 degree sheets will be contained in one sheet of the 1-millionth series. Thus by giving a number to each (1-M) sheet, letters from A to P to each of its component degree sheets and an additional number 1 to 16 to each of the 1-inch standard sheets, these letters and numbers having definite positions in the 1-M map in which they fall, we shall be able to locate and ask for any (1-M) one to a Million sheet, degree sheet or 1-inch standard sheet by reference to a single index map for the whole of India; but in order to simplify matters, index maps for each 1-M map showing its component degree and standard sheets will be prepared.

15. The production of these 3 series, each map of which covers an area of either 4°, 1° or 15′ Latitude and Longitude according to the series to which it belongs will enable us to publish atlas volumes of convenient dimensions.

Thus the degree sheet atlas series would consist of a (1-M) one to a Million sheet followed by its 16 component degree sheets, while the 1-inch atlas series would consist of a degree sheet followed by its 16 component standard sheets and in time these atlases might be supplemented by an index of the village and other names shown on maps.

16. The Department is at present quite unequal to coping with the work suggested for it and it will take several years before it will be possible to train the required number of native surveyors, though it will be a comparatively easy matter to procure the necessary number of Imperial and Provincial officers.

17. The increase in the field establishments and consequent increase in the yearly outturn of mapping will swell enormously the work of the reproducing offices and their present organisation is unsuited to cope with it, but it is hoped by re-arrangement that it may be possible to carry out all that is necessary without any material increase in expenditure, but when it is remembered that the survey and preparation of a 1-inch standard sheet for reproduction amounts probably to not less than ₹10,000 and that the cost of reproduction by heliozincography amounts to approximately but ₹84 per hundred copies, it would seem advisable not to fear some extra expenditure under the latter head, but rather to endeavour in every possible way to make our resultant maps as good as possible by employing the best methods that are at our command.

18. It is understood that all the sheets of the 1-M and degree sheet series will eventually be engraved and possibly a large number, if not all, of the 1-inch standard sheets.

19. Great trouble is experienced in getting good lithographic stones and a considerable number of "faked" stones have broken up under the pressure of continuous printing.

20. Many complaints have from time to time been made in the Department of the quality of the paper on which our maps are printed and one of the greatest difficulties to be contended with in the printing section is registration.

This difficulty will be much more felt in the future when we shall have to print our maps in 4 or 5 colours instead of at the most 2, which was the custom for the topographical maps of the past and some special arrangements seem necessary to insure an adequate supply of reliable paper from England in future.

21. Perhaps the most difficult problem that a Surveyor General of India has to deal with when attempting to survey and map on an uniform system a vast country containing such mountain ranges as the Himalayas and such plains as those of the Punjab, Bengal and Rajputana with such elevated plateaux as Baluchistan, etc., is to decide on a vertical interval between contours on any one scale that will suit all classes of country and meet the requirements of the people for whom the maps are most useful.

The scale with which we are at present most closely connected is that of 1 inch=1 mile. For ordinary purposes it is probable that an interval of 50 feet between the contours would be sufficient, though a much smaller interval would, in flat or gently undulating ground, be much more valuable; but in the massive hills and mountains of India, to attempt to show contours at such intervals would be impracticable and utterly disproportionate to the value of the labour involved in surveying them. I believe that no system has yet been evolved by any country which deals satisfactorily from a systematic and artistic point of view with this question. If any light can be thrown on this question by any student of the subject, his conclusions would be most gratefully welcomed. My present suggestion is to show on each map a coloured line below which contours may be accepted as representing differences of level of 50 feet and above which the hills will be merely artistically defined, as great a number of heights being shown on the hill tops, at passes and along the ridges and where possible on spurs, as may be convenient.

22. It must be recognised that in an enormous area such as India, cut up as it is by so few permanent roads or railways, and inhabited by but few wealthy or educated communities, it is out of the question to hope to be able to either establish or maintain bench marks on the scale found to be possible in European countries, without involving the country in an ever-recurring expenditure of considerable magnitude and no survey that is made at the present time except in highly cultivated tracts can be so made as to insure a re-survey being carried out from the marks that may be found on the ground hereafter, without very considerable expense and revision.

23. In the Ganges valley, the plains of the United Provinces and of the Punjab, the village trijunctions will, let us hope, always be maintained and will thus form permanent marks on which to base our surveys, but in the less populated tracts and in the hills no such marks are of any practical value to a surveyor working on the small scale on which it is proposed to survey the country, and every succeeding generation of surveyors will have to clear and supplement such of the old marks as may be found on the ground before it can attempt to revise the maps.

24. The courses of the large rivers and even of comparatively small ones are absolutely unconfined in the plains of India and the influence they exert on the features of the country can hardly be realised by persons not engaged in the actual preparation of maps of any particular district. As a consequence it will probably be found in the future as in the past that the maps of one year cannot be satisfactorily joined up with those of any previous years, where rivers are involved. To attempt to revise maps yearly or even at intervals of ten years, however, for the purposes of co-ordinating adjacent maps would be out of the question and in consequence the Committee recommended limiting the revision of the maps during the first period of 25 years to the insertion of fresh roads, rail-roads and canals, but the construction of either new roads, rail-roads or canals involves a large increase of population and consequently the growth of new villages and other artificial works and the conversion of jungle or waste land into cultivation—all or any of which changes render maps immediately obsolete and somewhat misleading, and it would seem necessary to make the occasional revision more frequent in areas in which important changes were from time to time occurring.

25. One very satisfactory point in the Committee's report is the recommendation that the scientific work of the Department should not be curtailed beyond the handing over to the local authorities of the tidal observatories and work

connected with them. It would probaby however be found impossible to find at the various ports officers capable of carrying out the work, and a central office under a special officer would in any case be necessary. The effect of such a transfer would have no practical effect on the topographical work of the Survey of India, as it does not even now claim the whole time services of even one Imperial officer.

The Committee recommended that the present strength of Imperial officers attached to this branch should be increased by two in order to meet present requirements.

26. The photozincographic office, Calcutta, labours under great difficulties at the present time. Its establishment is a fixed one and there is no elasticity: there is no supply of trained men in India capable of dealing with any of the technical duties, from which this office could recruit its members or fill its casualties, and consequently except in the case of men specially recruited in England to fill the more important posts every member has to be trained in the office itself and while under training occupies a post that should be filled by a competent man. Further there is no regular supply of work and purely departmental work has constantly to be set aside in order to comply with the urgent demands of other Government offices and departments, and the Survey of India work is consequently almost invariably in arrears.

There is urgent need for reform and a complete reorganisation as regards the distribution of the work and the payment of the employees and it is hoped that this will shortly be effected.

27. Under the present organisation the drawing and reproducing offices are under different officers and are entirely independent of each other. They are under different roofs and consequently a certain amount of friction is inevitable. In any re-organisation it would seem advisable to place these offices under one authority each as a section of one and the same office.

28. The work of the Drawing and Reproducing offices during the year under report was very materially interfered with by the work thrown on them by the Survey Committee. This is not tangible but is none the less real, and all members in both offices did their utmost to supply all the information that was required of them.

29. I do not consider the shortcomings of these offices are due to the inattention of the assistants, who have worked well in as trying a climate during the greater part of the year, as any in the world for Europeans, but that they are due to the system. There can be no doubt that a move to some station where the climate is better and the fluctuations in humidity are less frequent and sudden will materially improve the work and enable a greater out-turn to be produced yearly.

Inspection Tours of Administrative Officers.

30. Colonel Hobday, I.A., Officiating Surveyor General, left Calcutta on the 20th March for Dehra Dún, where he inspected the offices of the Superintendent, Trigonometrical Surveys, and the Superintendent, Forest Surveys. From there he proceeded to Ráwalpindi on the 1st April to inspect the field work of No. 18 Party and of the Cantonment Section of No. 15 Party. He returned to Calcutta on the 14th April. On the 1st of May he proceeded to Simla and on the 4th idem handed over charge of the office of Surveyor General to Lieutenant-Colonel Longe, R.E., who remained at Simla till the 14th July, during which period he inspected the recess office of No. 18 Party on several occasions. He left Simla on the 15th July and arrived at Dehra Dún on the following day. While at Dehra Dún he held a conference of Survey officers which discussed various questions in connection with the future preparation and reproduction of standard maps and other questions connected with the Department. On the 26th July he proceeded to Mussooree and inspected the offices of Nos. 14 and 15 Parties and the North-West Frontier Drawing Office located in that station. On the 9th August he left for Bhím Tál to see whether suitable sites for the location of a drawing office and for the recess quarters of field parties could be found there. He proceeded to Naini Tal on the 15th and inspected the Drawing Office there and also conferred with the Secretary to the Government of the United Provinces and the Superintendent, Provincial Surveys, regarding future survey work in that province and the future of the Drawing Office and returned to Calcutta on the 24th August. He had intended to inspect the offices at

Bangalore and Poona, but was compelled to abandon this trip and to proceed again to Mussooree to settle the composition and field programmes of Nos. 12, 14 and 15 Parties until the 12th October when he proceeded to Dehra Dún. While in Mussooree he again inspected the office of No. 1 Party and the North-West Frontier Drawing Office on several occasions. While at Dehra he inspected the office of the Superintendent, Forest Surveys, and that of No. 20 Party, and in connection with the Superintendent, Forest Surveys, prepared a scheme for the future working of the Forest Survey Branch parties which was duly submitted to the Government of India. He returned to Calcutta on the 20th October.

31. Lieutenant-Colonel Hodgson, while officiating as Deputy Surveyor General, inspected Nos. 1 and 2 Parties in the Central Provinces and Berar during January 1905 and inspected the work of two Provincial officers and two surveyors in the field. Before returning to Calcutta he proceeded to Lucknow to meet Captain Coldstream, Superintendent, Provincial Surveys, in the United Provinces with a view to discussing various matters with him in connection with the future conduct of surveys in those provinces. Colonel Hobday after handing over the office of Surveyor General to Lieutenant-Colonel Longe at Simla in May 1905 proceeded to Dehra and inspected the progress of the Tibet mapping. He then proceeded to Mussooree and inspected Nos. 1 and 14 Parties. Thence he proceeded to Darjeeling and attended a conference of the Board of Revenue of the Lower Provinces, when proposed changes in procedure (which have since been carried out) were discussed.

In June he inspected the four field parties recessing at Bangalore and the Bangalore Drawing Office.

32. Lieutenant-Colonel Burrard, Superintendent, Trigonometrical Surveys, proceeded to Karáchi and inspected No. 12 Party (Sind) in March 1905. He visited Mussooree in June 1905 and inspected the detachment of No. 25 Party and in September 1905 he inspected the recess offices of Nos. 23, 24 and 26 Parties. He also inspected Nos. 22 and 25 Parties (Tidal and Levelling) and the Survey Training School during the year from time to time.

33. Major Gordon inspected No. 20 Party in the field in Burma and also the detachments of No. 9 Party working in Assam, Bengal and Burma. He inspected the recess offices of No. 17 Party at Poona, No. 20 Party at Dehra Dún and No. 19 Party at Bangalore. While at Bangalore he attended a conference held by direction of the Madras Government, at which the Conservators of circles and the Deputy Director of the Madras Revenue Survey were present to discuss matters connected with forest surveys in the Presidency.

DISTRIBUTION OF FIELD PARTIES.

34. Field operations were carried on by 23 parties and 2 detachments; of these 9 were employed on topographical surveys, 4 on forest surveys, 5 parties and 2 detachments on cadastral surveys, 1 on triangulation, and 4 on scientific operations. In the following statement the whole of the operations are grouped according to the nature of the work on which the parties were employed.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of survey.	Administrative Superintendent.
	Topographical.	PAGE.		Inches. Miles.	
1	Central Provinces . .	23	Captain A. H. B. Hume, R.E. Mr. W. M. Kelly . .	2 = 1	D. S. G.
2	Berar	24	Captain E. T. Rich, R.E. . .	2 = 1	Ditto.
3	Lower Burma . . .	25	Mr. E. F. Litchfield . . .	1 = 1	Ditto.
10	Upper Burma . . .	26	Captain C. P. Gunter, R.E. . „ E. T. Rich, R.E. . .	1 = 1	Ditto.
11	North-West Frontier . .	28	Major J. M. Burn, R.E. . Lieutenant C. M. Browne, D.S.O., R.E. „ R. H. Phillimore, R.E. .	2 = 1	S. G.
12	Sind	29	Mr. C. F. Erskine . . . „ R.F. Warwick . . .	Various	Supdt., Trig.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of survey.	Administrative Superintendent.
		PAGE.			
14	United Provinces	30	Captain H. L. Crosthwait, R.E.	2 = 1	S. G.
15	North-West Frontier	31	Captain F. W. Pirrie, I.A. Major C. L. Robertson, R.E.	Various	S. G.
18	Punjab	32	Captain E. A. Tandy, R.E. „ M. O'C. Tandy, R.E.	Do.	S. G.
	Forests				
9	Bengal Assam Punjab North-West Frontier Prov. Central Provinces Burma	34	Major C. W. H. Symonds, I.A. „ P. J. Gordon, I.A.	4 = 1	
17	Bombay Presidency	35	Mr. B. G. Gilbert-Cooper	4 = 1 8 = 1	Supdt., Forest Surveys.
19	Madras Presidency	37	Major C. L. Robertson, R.E. Mr. G. T. Hall	4 = 1	
20	Burma	38	Captain A Mears, I. A.	4 = 1	
	Cadastral and Traverse.				
4	Bihár	40	Lieutenant L. C. Thuillier, I.A.	16 = 1	S. P. S., Bengal.
5	Chota Nagpur	41	Captain F. C. Hirst, I.A.	16 = 1	Ditto.
6	Eastern Bengal	42	Mr. A. W. Smart	16 = 1	Ditto.
Det.	Calcutta Suburbs	44	„ R. B. Smart	1056 = 1	Ditto
7	Burma	45	Lieutenant-Colonel G. B. Hodgson, I.A. Major C. W. H. Symonds, I.A.	16 = 1 528 = 1	D. S. G.
8	United Provinces	47	Captain W. M. Coldstream, R.E.	16 = 1	Ditto.
Det.	Assam	50	Mr. T. Shaw	.....	Ditto.
	Trigonometrical.				
24	India (Triangulation)	51	Captain H. H. Turner, R.E.	.....	Supdt., Trig.
	Scientific.				
22	India (Latitudes)	51	Lieutenant-Colonel S. G. Burrard, F.R.S., R.E. Captain H. M. Cowie, R.E.	.....	Supdt., Trig.
23	Do. (Pendulums)	52	Major G. P. Lenox-Conyngham, R.E.	.....	Ditto.
25	Do. (Tidal and Levelling)	54	Major J. M. Burn, R.E. Mr. J. P. Barker	.....	Ditto.
26	Do. (Magnetic)	56	Major H. A. D. Fraser, R.E. Captain R. H. Thomas, R.E.	.....	Ditto.

OUTTURN.

35. The total outturn of detail survey during the year amounts to 121,588 square miles which includes 88,850 square miles of geographical surveys; the area surveyed during the previous year amounted to 58,464 square miles which included a geographical survey of 24,100 square miles; the total area triangulated is 28,230 square miles against 22,496 last year.

The total area traversed for cadastral purposes is 7,645 square miles, *viz.*, 323 square miles in the United Provinces, 6,326 square miles in Bengal, 645 square miles in Burma, and 32 square miles in the Central Provinces and 80 square miles in Assam.

TOPOGRAPHICAL SURVEYS.

36. During the year under report the locale of operations of No. 11 Party was changed for the year from the Shan States to the North-West Frontier; with this exception, the work was carried on in continuation of previous years.

37. *Punjab.*—No. 18 Party continued the supplementary surveys in the province on the 2-inch scale, utilizing and verifying the detail compiled from settlement *masavi's* fitted together by means of traverse points. The area completed was 1,511 square miles in Multán and Muzaffargarh districts. The originally sanctioned programme had to be considerably modified on account of a special 6-inch survey which the party was ordered to make for the military authorities on which the most experienced surveyors of the party were employed.

38. *United Provinces of Agra and Oudh.*—No. 14 Party topographically surveyed on the 2-inch scale an area of 1,908 square miles, and completed 518 square miles of revision and supplementary survey in districts, Allahabad, Fatehpur and Cawnpore. The survey of the first two districts mentioned above is now complete. No. 8 Party completed 167 square miles on the 2-inch scale.

39. *Central Provinces.*—No. 1 Party completed the supplementary topographical survey on the 2-inch scale of 2,719 square miles, and 483 square miles were surveyed by No. 2 Party on the same scale.

40. *Sind.*—An area of 3,937 square miles was topographically surveyed by No. 12 Party in this province.

41. *Baluchistan and North-West Frontier Province.*—An area of 1,509 square miles was topographically surveyed by No. 15 Party and 982 square miles were completed by No. 11 Party.

42. *Burma.*—Nos. 3 and 10 Parties were employed on topographical surveys in Burma and surveyed 7,513 square miles on the 1-inch scale, of which 4,365 square miles consisted of supplementary survey and 1,070 square miles on the Burma-China Boundary.

43. *Bengal.*—The survey of the bed of the Kosi river on the 4-inch scale was continued and 252 square miles was completed during the season in conjunction with the cadastral survey in the Bhágalpur and Purnea districts.

In the Backergunge Sundarbans 227 square miles were surveyed on the 4-inch and 93 miles on the 2-inch scale.

44. The total outturn for the year under the head of new topographical survey and supplementary survey on the scale amounts to 20,582 square miles as follows:—

	Square miles.
Punjab	1,511
United Provinces	2,593
Central Provinces	3,202
Sind	3,937
Baluchistan and North-West Frontier	2,491
Burma	7,513
Bengal	572

FOREST SURVEYS.

45. The operations of the Forest Survey Branch are fully reported on in the Forest Survey report and are therefore only briefly mentioned here. They were generally in continuation of those of the previous season. By the end of next year the survey on the 4-inch scale of the most important forests in the North-West Frontier Province, the Punjab, the United Provinces, and in the Central Provinces, with the exception of Berar, will have been completed. In Burma, Assam, and in the Central Provinces the local Governments have, at the instance of the Inspector General of Forests and with the approval of the Surveyor General, agreed in principle to the remaining forest areas being surveyed on the 2-inch scale, the cost of such surveys being borne by the Survey of India. In Bengal the only important forest tracts for which special surveys are now required, are the extensive reserves in the Sundarbans; as special training and arrangements are necessary for this work, it is proposed that it should be carried out by one of the Revenue parties at present employed on the survey of the

non-forest portions of the delta. These proposals are in accord with the recommendations of the Indian Survey Committee.

46. The Madras Government has been approached with a view to a similar policy being adopted in that Presidency.

In Bombay forest surveys are so far advanced that no change in the present general programme is contemplated.

47. *Madras.*—No. 19 Party in addition to triangulation and traversing surveyed an area of 750 square miles on the 4-inch scale in Ganjám, Gódávari, North Coimbatore and South Canara. A test survey on the 1-inch scale over an area of 135 square miles was also made for the Indian Survey Committee and a surveyor was lent to the Madras Government to assist in the demarcation of the Mysore—South Canara boundary. These operations to a certain extent affected the outturn of 4-inch surveys and consequently the cost rates.

48. *Bombay.*—No. 17 Party in addition to triangulation, surveyed an area of 187 square miles on the 8-inch scale in Násik and Thána and of 597 square miles on the 4-inch scale in Násik, Khándesh and Sátára. A portion of the boundary between Khándesh and the Barwáni State was also traversed at the request of the Bombay Government.

49. *Burma.*—No. 20 Party surveyed an area of 680 square miles on the 4-inch scale in Upper and Lower Chindwin Pakôkku and Thayetmyo districts. Two strong detachments of No. 9 Party were also employed in Burma and surveyed an area of 501 square miles in the Irrawaddy basin chiefly in Katha and Shwebo. A large area was also traversed and triangulated in advance by both parties. Recent forest surveys in Burma have brought to light the rapidity with which the coast line on the western side of the Gulf of Martaban is advancing, the margin of the sea being now at some points as much as 6 miles from where the surveys of 12 years ago show it to have been then.

50. *Bengal.*—A detachment of No. 9 Party completed the survey on the 4-inch scale of the forest reserves in Angul, an area of 232 square miles.

51. *Assam.*—In Assam an area of 148 square miles of forest was surveyed on the 4-inch scale by No. 9 Party in the Gáro Hills, Nowgong and Kámrup in addition to traversing and triangulation in Darrang and Sibságar.

52. *Punjab and North-West Frontier Province.*—A small detachment of No. 9 Party under a native surveyor was employed throughout the year and completed the survey of an area of 202 square miles chiefly in Jhelum and Hazára.

53. Traversing and triangulation were carried out in advance of detail survey in Berar and five surveyors were lent to the Forest Department for the purpose of surveying the boundaries of recently demarcated mica-mine grants in Kodarma.

54. Except in Madras the cost rates do not call for special notice, being as a rule practically the same as for last year. In Madras the outturn for the year is the smallest and the cost-rates are the highest that have been reported in No. 19 Party for many years and this state of affairs cannot be altogether satisfactorily explained by the undoubted disadvantages which this party suffers from in respect of the scattered nature of the work and the difficulties of supervision; the work lies entirely in unhealthy tracts generally remote from villages; it is of a monotonous character and extremely distasteful to the class from which the surveyors are recruited, and continued ill-health has helped to discourage them. The work however is generally of good quality, and it is hoped that better results will be obtained next season.

The total outturn of topography done by the Forest Survey Branch during the year was 3,358 square miles made up as follows :—

Scale 4-inches = 1 mile	3,171	square miles.
„ 8 „ = 1 mile	187.	„

CADASTRAL AND TRAVERSE SURVEYS.

55. One party was employed on cadastral and traverse operations in the United Provinces, three parties and one detachment in Bengal and one party in Burma. One detachment was employed on traversing only in Assam.

56. In the United Provinces in the Moradabad district, 323 square miles were traversed and 349 square miles surveyed cadastrally. Three hundred and nineteen square miles of previous cadastral surveys on the 16-inch scale were

revised and the records written of 895 square miles. The cadastral maps were revised and the annual records written of 720 square miles in the Bánda district and of 782 square miles in Hamírpur district. The survey of Cawnpore city done in 1900-02 on the 64-inch scale was revised and a survey on the scale of 24 inches to the mile was made of an extension of the Hápur Remount depôt area 1·6 square miles.

57. In Bengal 935 square miles were traversed for topographical survey and 5,388 for cadastral survey: 4,476 square miles were surveyed cadastrally on the 16-inch scale and the records written of 4,507 square miles.

The survey of the suburbs of Calcutta and Panchánnagrám Government Estate was continued; 3 square miles were traversed and surveyed on the scale of 32 inches to the mile and 2 square miles surveyed on the scale of 50 feet to the inch. The records of the entire area were written.

58. In Burma the survey of the Pakôkku district was continued; 747 square miles were traversed and 819 square miles surveyed on the 16-inch scale.

The survey of the town of Rangoon was extended over an additional area of 9·3 square miles.

59. In the Central Provinces an area of 32 square miles consisting of forest excisions and scattered villages was traversed by one of the topographical parties for survey by local agency in the Chánda and Hoshangabad districts.

60. In Assam 60 square miles of tea grants and 20 square miles for survey by local agency were traversed. In addition 28 linear miles were traversed along the Dibru-Sadiya railway.

61. The total areas traversed and surveyed cadastrally are as follows:—

Province.	Traversing.	Cadastral survey.
United Provinces	323	2,171 (*a*)
Bengal	6,326	4,481 (*b*)
Burma	747	645
Central Provinces	32	.....
Assam	80	.....
TOTAL	7,308	7,297

(*a*) Includes 1,821 square miles of revision survey.
(*b*) Includes 11 square miles of miscellaneous surveys.

TRIGONOMETRICAL SURVEYS.

62. The triangulation party (No. 24) was transferred from Eastern Burma to Baluchistan, and commenced work on a series of principal triangulation trending westwards from Kalát. As points were required for topographical purposes, the new series was made to emanate from a side of the secondary triangulation of Kalát, and its connection with the principal triangulation of India was postponed till a later date. It extended the triangulation westward, a distance of 130 miles: nine triangles were completed and the average triangular error was 0·667 seconds.

SPECIAL OPERATIONS.

63. To complete the geodetic data furnished by the great arc of parallel between Karáchi and Moulmein, it was necessary to take astronomical observations for latitude and azimuth at the four longitude stations east of Calcutta, namely Chittagong, Akyab, Prome and Moulmein. In 1905 Captain H. M. Cowie observed for azimuth and latitude at Chittagong, and for latitude at Akyab, Prome and Moulmein azimuths having been already observed at these places.

64. Pendulum observations were taken at ten stations situated on the Calcutta meridian. The most southerly station was at Cuttack in Orissa and the most northerly at Sandakphu in Sikkim. Of the ten stations, three were in the Himalayas, two at the foot of the Himalayas and five on the flat alluvial plains of Bengal and Orissa. Owing to the unceasing vibrations of the ground, satisfactory pendulum observations in Calcutta itself were found to be impossible.

65. Tidal operations were continued by No. 25 Party, observations being recorded at nine stations.

Levelling operations were carried through Sind along the left bank of the Indus. During the recess season a second levelling detachment was organised.

66. Four detachments of No. 26 Party extended the field-work of the magnetic survey over different portions of the country. The base station at Toungoo was opened during the year and is now working satisfactorily: in the original design of the magnetic survey, five base-stations were included and they are all now at work.

GEOGRAPHICAL SURVEYS.

67. Under this head are included surveys and reconnaissances which are executed on the $\frac{1}{4}$-inch and smaller scales. The survey detachment with the Somaliland Field Force completed an area of 1,253 square miles on the $\frac{1}{4}$-inch scale and 17,687 square miles on the $\frac{1}{4}$-inch scale. A narrative report of this work from its commencement in 1903 will be found in the appendix. The maps were prepared by Captain Beazeley in England and have not been published by the Survey of India.

Captains Ryder and Wood, R.E., completed 40,000 square miles of survey on their return journey from Gyang-tse *vid* Shi-ga-tse and Gartok to Simla. This, although actually surveyed during the year under report, was fully described in the General Report of last year and is only mentioned here.

The survey detachment with the Seistan Mission completed42,000 square miles, of which 15,000 square miles were reported last year.

One native Provincial officer and three Surveyors were detached from No. 10 Party (Burma) to accompany two expeditions despatched by the Burma Government to determine and demarcate the Burma-China boundary, and 1,070 square miles were surveyed on the 1-inch scale and 2,970 square miles on the $\frac{1}{4}$-inch. The 1-inch survey included the road from Bhamo to Tengyueh (Momien). One Surveyor was sent with Dr. Stein and another with Mr. Lorimer.

HEAD-QUARTERS OFFICES, CALCUTTA.

68. The general direction of these offices remained in the hands of Colonel F. B. Longe, R.E., except for the period from 10th November 1904 to 3rd May 1905, when Colonel J. R. Hobday directed the offices. The Surveyor General's and the Mathematical Instrument Offices were under Brevet Lieut.-Colonel T. F. B. Renny-Tailyour, R.E.; the Drawing, Engraving and Map Record and Issue Offices under Major W. J. Bythell, R.E., and the Photo.-Litho. Office under Mr. T. A. Pope, throughout the year.

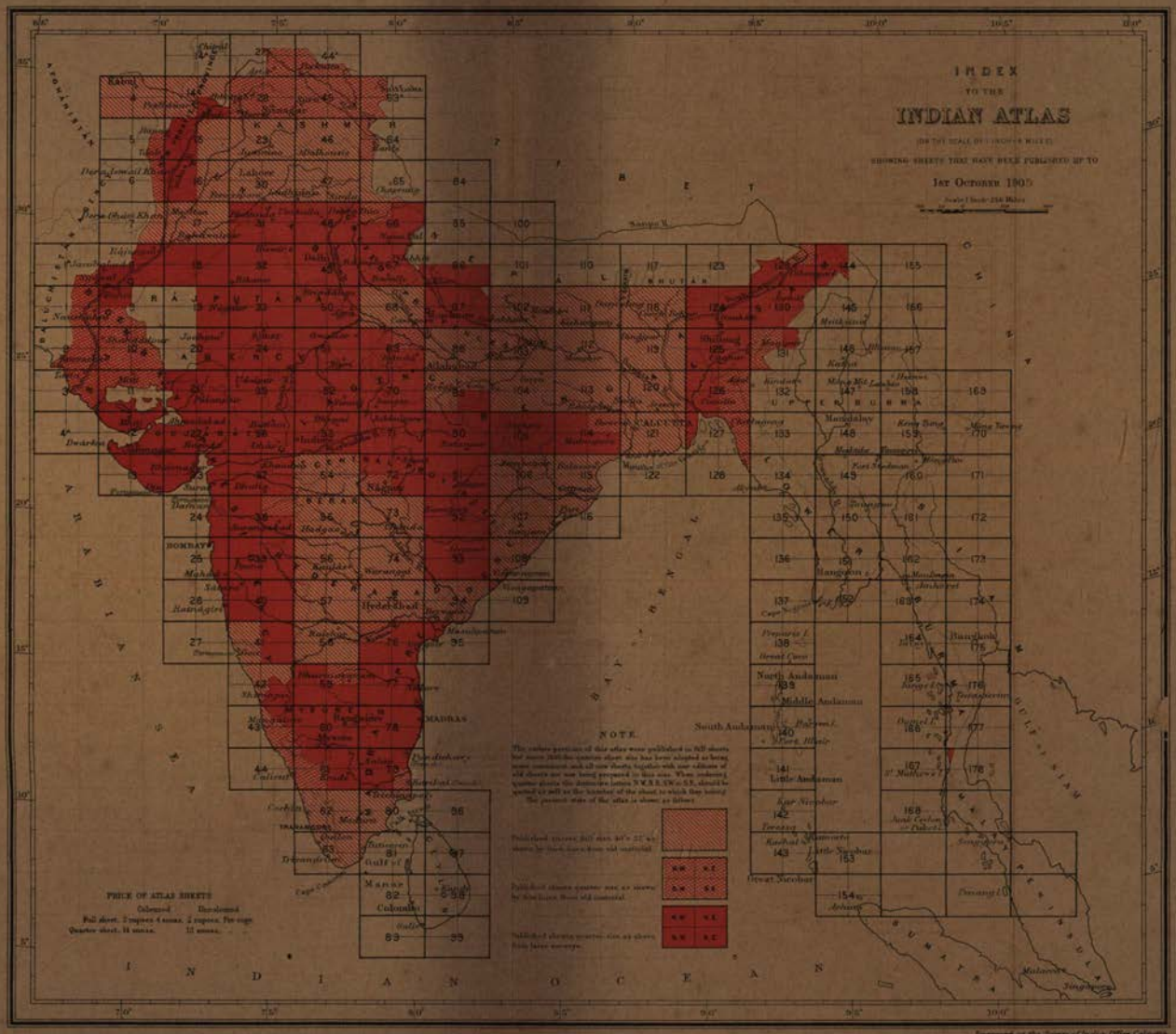
69. *Drawing Office.*—The General Section has, throughout the year, continued the work of the compilation and preparation of the general maps together with their revision, and the addition of new material to the sheets of the Atlas of India for the Engraving Office. A large amount of work has been done on the standard sheets by the addition of new material and by their general revision when new editions and reprints are required.

One hundred and eighty-one sheets of the Atlas of India have been brought up to date for the Engraving Office by additions and corrections to railways, roads, canals and boundaries. Eight sheets have been similarly prepared to be printed after transferring to stone in the Photo.-Litho. Office. The hills of four sheets have been brush shaded as samples for the engravers to work from, and the brush shading of five more is in hand.

Eleven general maps of India on scales ranging from 32 miles to 256 miles to the inch have been in hand during the year, and of these, new editions of the 32 and 64-mile maps should shortly be ready. The publication of these, which, as noted in last year's report at paragraph 43, had been considerably delayed was again retarded by extensive boundary changes in the Central Provinces, Bengal and Assam.

Seventeen sheets of the map of India and adjacent countries on the scale of $\frac{1}{1,000,000}$ were in hand, and fourteen were published or under publication.

Thirty-seven sheets of provincial maps, on the scale of 16 or 32 miles to the inch, have been in progress during the year, of which six were new publications and three new editions. Of the total seven were published or under publication.



Engraved at the Survey of India Office, Calcutta.

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Published under the direction of MAJOR F. B. LONGE, R.E., Officiating Surveyor General of India.

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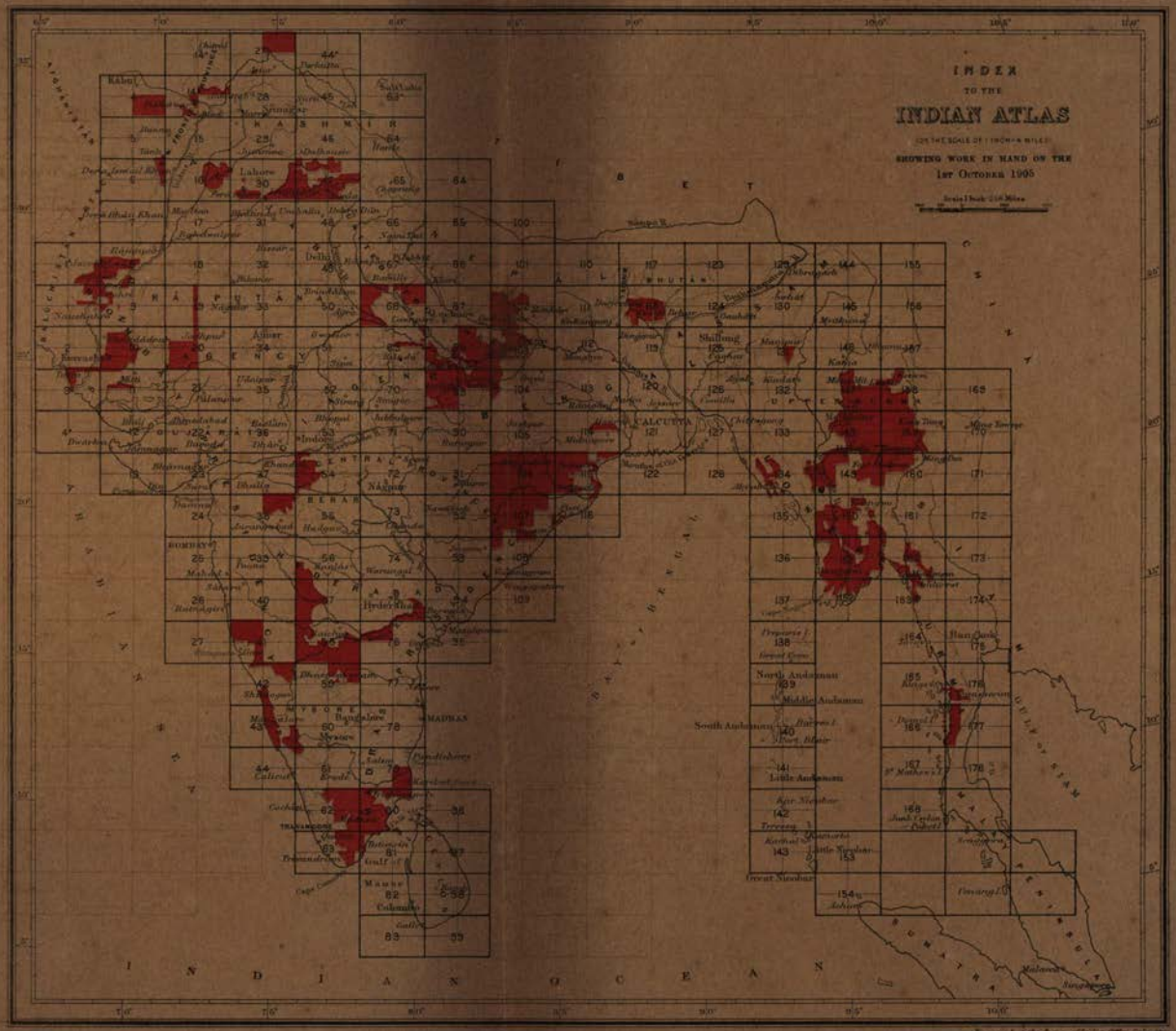
No. 633-S 1902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ON THE SCALE OF 1 INCH = 4 MILES
SHOWING WORK IN HAND ON THE
1st OCTOBER 1905
Scale 1 Inch = 256 Miles
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CENTRAL INDIA
BERAR
BOMBAY
HYDERABAD
MYSORE
MADRAS
TRAVANCORE
CALCUTTA
BHUTAN
North Andaman
Middle Andaman
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Great Nicobar
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Sixty-one district maps on the quarter inch to the mile scale were brought up to date or completed, of which twenty-one were published, and twenty-one are under publication. Ten of the above are new publications, and five new editions.

The large total of two hundred and eighty-six Standard Sheets on the 1-inch scale have been in hand during the year, of which one hundred and forty-one have been published, and sixty have gone to press for publication. Of the above thirty-one are new publications, and thirty-two are new editions. Seventy-nine of these sheets were of Central India and Rajputana, thirty-four of Bombay, forty-six of Burma, twenty-nine of Madras, forty-four of the North-West Trans-Frontier and sixteen of Bengal.

Four of the Burma Degree sheets on the quarter-inch scale were in hand during the year and all were sent to press for publication.

Twenty-six Administration Report maps on the scale of eight miles to the inch were in hand during the year, of which twelve were published, four are under publication, and ten are in hand.

Twenty-three Index maps were in progress. Of these, eleven were brought up to date and published, seven were completed and published for the Survey Committee, and the remainder are either under publication or in hand.

A total of one hundred and thirteen sheets of large scale plans of cities and Cantonments have been dealt with, of which sixty-three were published, twelve are under publication, twenty-six have been brought up to date for publication, and twelve are in hand. Some thirty miscellaneous maps have also been dealt with, whilst two triangulation charts have been published, and nineteen are under publication.

As usual the demands for extra-departmental work in this Section have been very heavy, entailing the permanent loss throughout the year of the services of a considerable number of skilled draftsmen who might, could this work have been carried out elsewhere, have been employed on purely departmental work. The arrears mentioned in paragraph 44 of last year's report have, if anything, increased, and there seems to be no possibility now of coping with them.

The Postal maps have constituted a heavy item of the extra-departmental work, as those of no less than six provinces, involving an aggregate of one hundred and ten sheets have been dealt with. The Postal map of Bengal has been published, and those of the Central Provinces and United Provinces are under publication.

70. The "Examining Section" has passed 2,352 sheets and has carried out a considerable amount of miscellaneous work, such as the supply of geographical data to various officials, computation of graticules, notes on orthography of names, etc.

71. In the "Revenue Section" four hundred and seventy-three sheets have been dealt with, of which one hundred and thirty-eight are new publications. Sixty-three are new editions, and one hundred and seventy-seven are reprints. Ninety-five plans and tracings of villages have been supplied to Local Governments. The 138 new publications were all received from Drawing Offices elsewhere or from the field parties. These were cursorily examined and sent to press.

The preparation of one inch Standard Sheets of Bengal from old materials, mentioned in the second section of paragraph 46 of last year's report was stopped on the 15th of July by order of the Survey Committee, and the Provincial Officer in charge and the ten draftsmen comprising the "Arrears Section," as it was called, transferred elsewhere. During the year the draftsmen were employed they showed considerable improvement in drawing, and completed 34 sheets in all.

All the computations of the Gódávari Detachment's work, comprising the work of two field seasons, were examined in this Section; and a very considerable amount of typing has been carried out on the original traces of the Survey.

Two thousand four hundred and ninety-seven pages of traverse data have been copied and examined and supplied to local or district officers, the majority of the work falling in Burma.

The miscellaneous work of this Section has been very heavy throughout the year and included the preparation of full statements showing the area, season, scale and date of every class of survey in each province and district of India and Burma from the year 1830 to the present date. This statement was prepared for the Survey Committee. The number of applications received

from private individuals for copies of maps, etc., during the year amounted to 1,146, in response to which 2,008 authenticated copies were issued, the Government fees realized thereon amounting to R1,225-8-0.

72. In the Office Copy Section, the formation of which was noted in the last section of paragraph 46 of last year's report, a total of 25,352 coloured copies of maps were examined and passed. Nine hundred and twenty-six sheets were coloured for office copies. One thousand eight hundred and seventeen office copies on various scales were corrected, and 549 were examined and certified.

73. *Engraving Office.*—The outturn of work completed by this office is much the same as last year:—

Five new quarter sheets of the Atlas of India, Nos. 21 N. W., 25 N. E., 36 N. W., 40 S. E., and 59 S. E., Punjab 16 miles without hills in four sheets and sheets 86 and 87 of India and adjacent countries on the one-millionth scale have been completed and published, the last two sheets being engraved for printing in black and brown.

The new map of India on the 64-mile scale is in hand, two sheets Nos. 2 and 3 for outline, and sheet 1 for the insertion of G. T. points. The duplicate map on the same scale is having the hills completed on sheets 1 and 2. Sheet 4 has been completed in outline and writing, and the hills will now be put in hand. The original map has had the railways brought up to date. The 80-mile map has been in hand throughout the year with corrections to date. The corrections to the 96-mile map have been completed. The writing on the new skeleton map of India 128 miles has been completed, and corrections have been carried out on the map of this scale with hills. Corrections have also been carried out on the 192 and 256 mile maps, but all the maps of India must now have the boundaries altered on account of the territorial changes in Bengal, Assam and Central Provinces. The additions and corrections to the Himalayan Route map have been completed, but as the hand-book is being revised, further corrections are expected before copies can be printed.

The boundaries and district names have been cut on the 1-inch=16 mile provincial map of Bengal, and slight corrections carried out on the Central India agency map on the same scale. The map of the Madras Presidency has been undergoing final corrections before publication. The maps of Mysore (1-inch=16 miles) have been in hand for correction. The writing on the 1-inch=32 mile Punjab is in progress. Thirteen provincial and seventeen district maps for Administration Reports, and four Index maps have been corrected and added to.

Sheet 2 of the sixteen inch plan of Calcutta is being corrected. Some additional names have been cut upon the 6″ plan of Calcutta, but it has now been stopped, as the spelling list supplied by the Municipal Corporation does not agree in spelling with the names placed on the streets. The 3″ plan of Calcutta has been completed in outline and many of the street names, which are unlikely to be changed, have been cut.

Twelve new scale plates have been engraved, eleven miscellaneous plates cut and added to, and seventeen Heliogravure plates for the Photo.-Litho. Office have had titles and foot-notes engraved.

Seventy-one new quarter sheets of the Atlas of India have had new material cut on them, 107 published quarter and full sheets have been brought up to date, and 23 quarter plates have been projected or had borders cut.

The copper plate printing office has worked well throughout the year and 43,450 impressions have been pulled.

The steel facing section has dealt with 420 plates, and 46 plates have been corrected from the surface by electro deposition.

74. *Photographic and Lithographic Office.*—The total outturn of printed copies of maps, plans and diagrams, both for the Survey of India and other departments, again shows a slight falling-off as compared with previous year's results. The total number of copies printed was 912,349 as against 968,145 in 1903-04 or 55,751 copies less. This shortage is largely accounted for by the increased outturn of departmental maps, which with their shorter runs involve much more frequent changes of plates. These last show an increase on the previous year's figures of 23,371 copies. The total number of departmental copies printed was 273,901, while of extra-departmental subjects, 579,573 copies were produced. This last is a considerable reduction on the last year's figures of

83,702 copies. Much outside work which was unsuitable for immediate photographic reproduction was declined, and it is intended to act still more on this line in future. It is evident that many who now submit inferior work which entails redrawing here, could easily, if so disposed, send in work suitable in every way.

75. In the Type Section there was a considerable increase in the outturn, the pulls amounting to no fewer than 2,292,749.

76. In the Heliogravure Section, while an increased (61) number of plates was prepared, many fewer prints were required from them, and the number of half-tone blocks required was also smaller than in the previous year, 51 having been prepared.

Experiments have been carried on by Mr. Turner with a view of ascertaining if brush shaded hill originals can be satisfactorily reproduced photographically and utilized on our maps, and with a considerable measure of success. These will be continued, and will be described when a method has been finally determined upon.

The want of efficient European supervision has been much felt during the year. The additional Assistants sanctioned, though on their way from England, had not arrived at the close of the year. The large increase of colour printing, owing to the adoption of colour in our standard sheets, will necessitate a large increase of work in the negative section, particularly in its retouching branch, and an increase in this establishment is inevitable. A better class of workmen is also required if good results are to be expected, and the services of a skilled operator on glass may be necessary to instruct the men in the latest methods which apparently are in advance of ours in this particular branch. The electric lighting plant for the illumination of the plan boards in the negative section has not yet arrived, but is expected any day, and its installation should much facilitate the work during the short cold weather days and in the rains. As the present method of graining plates is far from satisfactory, both as regards outturn and quality, an adaptation of the Block process is proposed. By this the ink is removed by turpentine and a caustic potash bath, and the plate is then placed with sand in a trough rocked on a ball and socket joint, glass marbles are then run over the surface of the plate until it is properly grained. Plant for working the above is now being prepared at the Mint, and is shortly expected.

77. In the Zinc Printing Branch the following were the more important departmental publications of the year.

Eight sheets of the map of India and adjacent countries were published, 300 copies of each being printed. The total number of standard sheets dealt with in the Negative Section was 375, and of these 181 were published, 14 being printed in two colours. The provincial map of Bengal on the scale of 1 inch = 16 miles was published and 800 copies were printed, while maps of Simla and Jutogh and Aden Cantonment and of the Civil Station and City of Delhi and of Secunderabad Cantonment were issued. For the Director of Land Records, Gwalior, 7,400 copies on cloth of 60 sheets of the Central India and Rajputana Surveys were printed, extra paper copies being at the same time printed off for stock. Of the Military Traffic Map of India on the scale of 1-inch = 80 miles in four colours, a further 1,500 copies, involving 6,000 pulls, were printed. Other extra-departmental work includes several maps for the Foreign Office. The map of India on the scale of 1-inch = 32 miles showing railways with stations was also published, and 37 diagrams for the Irrigation Conference for the Public Works Department of which over 25,000 copies were printed. A telegraph chart for the Director of Indian Telegraphs was issued, as also nine districts maps for the Assam Gazetteer, and a map of Nágpur City and Civil Station for the Executive Engineer, and 37 sheets of Pakókku Town Survey for that Municipality.

78. In the Litho. Section, the most important work has been that on the stones of the new map of India on the scale of 1-inch =32 miles. Corrections have been made to all the outline stones and proofs supplied, and these have been again received with what it is hoped may be final corrections. The work on the hill stones has progressed as opportunity offered throughout the year. Sheet 1 is approaching completion, and when this and a little work required on sheet 6 is finished, all the stones will be ready, and it is hoped the map may

be issued during the ensuing year. The provincial maps of Bengal on the scale of 1-inch = 16 miles and 1-inch = 32 miles, and of Assam and the United Provinces on the scale of 1-inch = 16 miles have also been in hand. The maps of the Madras and Bombay Presidencies on the scale of 1-inch = 32 miles have also been worked upon. Of district maps 36 have been taken up. Proofs of most of these have been submitted for approval; and 18 have been printed off. For the Bengal Government separate maps of each of the thirty Native States included in the province are being prepared on stone from copper plate transfers, and these are rapidly approaching completion. For the Foreign Office 36 maps have been drawn during the year, of which 30 have been printed off. Two Telegraph maps of India on the scale of 1-inch = 32 miles in 6 sheets, and of 1-inch=64 miles, have been worked on and printed off. The map of India on the scale of 1 inch = 80 miles showing railways, present and proposed, was corrected up to June 1904 and printed off, as was also the Railway Systems map in nine colours on the same scale. Copies of the military map of India and of the railway and canal map, both on the scale of 1-inch = 32 miles and involving much colour printing, have also been supplied during the year. Among other maps four maps for the Director General of Remounts have been in hand as opportunity offered, final corrections with press order having been received. Five maps for Dr. Grierson's Linguistic Survey have also been dealt with, and of these four have been completed while the remaining one is in proof.

79. The Lithographic Printing machine, the arrival of which was noted in last year's report, has been working throughout most of the year, but considerable trouble has been experienced with it. The remainder of the machinery has given little trouble. The change of motive power from steam to electricity still proves an unqualified success. A larger number of experienced pressmen for these expensive machines is however needed, and the marvel is that breakdowns are not more frequent, bearing in mind the staff at present employed on most of them. All over the office a better class of man is required. Wages which would obtain good men twenty years ago will not secure them now. At the same time really good work will never be obtained from *any* staff until the officer in charge has greater powers to regulate the pay and promotion of his men.

80. *Map Record and Issue Office.*—Ninety-five thousand three hundred and eighty-seven sheets of an aggregate value of ₹1,08,480 were issued during the year, an increase of 8,898 in number and of ₹4,380 in value on last year's figures. Of this total a sum of ₹13,516 was realized from private sales. The clerical work in connection with this office still continues very heavy, though there is a slight decrease on last year's figures.

The number of new maps received for publication was 128, whilst 795 were published, of which 296 were reprints. The number of original maps, volumes of records, etc., issued from store to other departments amounted to 5,831 of which 4,936 were received back again.

The transferring of the original Cadastral sheets from this office to various head-quarters of Local Governments or districts has been carried on steadily throughout the year. Those of 11 districts in the United Provinces of Agra and Oudh, of 10 districts in Bengal, of 3 districts in Assam and of one district in Burma, making a total of 44,861 sheets were duly despatched; 563 volumes of Field Area Statements were also despatched to various centres. This work is now practically finished as only 26 volumes of Cadastral maps and 182 volumes of Field Area Statements of District Gorakhpur remain to be despatched to complete the transfer of these records.

The rack accommodation at Dehra for the storage of Forest maps has not yet been completed, and in consequence the transfer of the large scale Forest maps and the opening out and re-storage of the special maps have had to be held in abeyance.

The work of revising the catalogues has also had to be suspended, owing to the presence of the Survey Committee at Head-Quarters, which threw much additional work on the staff, etc.

81. Two extra clerks on a salary of ₹60 per mensem were appointed to the Map Record Office during the year. With this small addition to the staff and the temporary re-employment of the late Head Clerk of this office who had retired in July 1904, a beginning has been made of a much needed overhauling,

re-arranging and re-classifying of the records and fair maps. For many years maps have been pouring into the office, many of them in a most fragmentary condition and owing to this accumulation and the hitherto imperfect manner of registration, it has not for a long time past been found possible either to accommodate the incoming new maps in their proper racks, or to keep pace with the growing needs of the Department. New registers have therefore been opened out in proper classified order, and the registration of the standard sheets comprising in all some 5,000 maps has been got through during the year. The re-arrangement of these by provinces will be undertaken as soon as space has been provided by the removal of other sheets. The work of overhauling the miscellaneous maps, plans and charts, general reports, computation volumes, angle books, etc., is being steadily proceeded with and it is hoped that before very long all obsolete maps and plans will have been weeded out and re-registered, and all those that are current, listed and made easily accessible when required.

82. *Mathematical Instrument Office.*—During the year under report, *i.e.*, from 1st April 1904 to 31st March 1905, the large demands which were made on this office in the preceding year have been maintained. For each of the last three years the value of instruments, etc., issued was ₹3,10,348, ₹3,64,646 and ₹3,54,005 respectively, and the value of repairs to instruments received for that purpose and returned in a serviceable condition was ₹32,242, ₹37,449 and ₹40,069 respectively. The value of instruments received from Government officers when "no longer required" during each of the last three years was ₹64,998, ₹74,066 and ₹85,994 respectively.

The book value of the stock in the serviceable store in hand at the end of each of the last three years was ₹4,72,065, ₹3,85,145 and ₹3,92,653 respectively. As this office receives no estimates from Government officers as to the probable number or class of instruments that they will require, it is impossible to keep this figure low and at the same time to comply satisfactorily with all the demands that are made. The privilege of being able to submit emergent indents on the Director General of Stores in addition to the annual indent has proved advantageous and since its introduction the value of the stock in hand has been greatly reduced.

The book-value of the stock in the repairable store at the end of each of the three last years was ₹1,80,999, ₹1,64,474 and ₹1,46,734 respectively. This stock mainly consists of obsolete instruments of historic value and of instruments for which there is only a very occasional demand; the latter are consequently not worth repairing until an actual indent is received when they are at once sent to the workshop, made serviceable and issued. Practically no instrument for which there is likely to be a demand remains in the repairable store for any length of time.

The "profit and loss statement" for the workshop shows a profit. The number of men and boys employed at the end of each of the last three years was 255,320 and 352 respectively. The extension of the piecework system continues to give beneficial results and the value of the total work done in the workshop during each of the last three years was ₹1,25,722, ₹1,50,567 and ₹1,58,958 respectively.

The value of instruments, etc., manufactured in the workshop for the serviceable store during each of the last three years was ₹47,729, ₹57,095 and ₹64,188 respectively; this continued increase represents a material saving to Government, as the issue price of these instruments has been considerably decreased. The value of instruments, etc., purchased locally for the serviceable store during each of the last three years was ₹13,329, ₹11,641 and ₹14,405 respectively.

83. The value of instruments, material, etc., obtained from England through the Director General of Stores during each of the last three years was ₹1,01,594, ₹1,46,509 and ₹1,91,113 respectively. These amounts must continue to rise, as there is no signs of the demand for instruments, etc., decreasing, and there is at the present time practically no reserve stock in the repairable store to fall back on.

BRANCH OFFICES, DEHRA.

84. *Trigonometrical Surveys.*—The superintendence of the Trigonometrical Branch was in the hands of Lieut.-Colonel S. G. Burrard, R.E., F.R.S., during

the year 1904-05. Mr. J. Eccles, M.A., was in charge of the technical offices up to the 2nd May 1905. Colonel Burrard, R.E., then held charge of this section till relieved by Lieut. C. M. Browne, D.S.O., R.E., on the 24th May 1905.

Messrs. W. M. Kelly and J. H. Nichol, Extra Assistant Superintendents, joined on 24th March and 1st May 1905 respectively. Ten Sub-Assistant Superintendents went through a course of training during the year.

The Computing section supplied manuscript data to 63 officers from the original records. Meteorological observations were taken as usual.

The following computations were carried out :—

(*a*) The Darjeeling revisionary triangulation including the snowpeaks observed by Messrs. Barckley and Pocock. The results are required for incorporation in the Synoptical Volume of N. E. Longitudinal series.

(*b*) The compilation of the N. E. Longitudinal series, Synoptical Volume was begun.

(*c*) The revision of certain tables of the 4th edition of the Auxiliary Tables was finished.

(*d*) The reduction of Lieut. Thomas's work in Tehri-Garhwál, and of Major Ryder's and Captain Wood's work with the Tibet Mission was completed.

(*e*) A provisional adjustment of the triangulation of the Burma Coast, Mandalay Meridional and Manipur Longitudinal series was made for Professor Helmert.

(*f*) A symbolical solution of equations for simultaneous reduction of spirit levelled heights was carried as far as the equations between indeterminate factors.

(*g*) Computations in connection with the deflection of the plumb line and many other computations of astronomical latitudes were done for incorporation in the G. T. Survey, Volume XVIII.

(*h*) One observed azimuth was computed and three others checked.

The revised pamphlet of rainfall has been printed, and large portions of Volume XVIII and of the 4th edition of Auxiliary Tables have been passed through the press.

In addition to those of this office proofs sent by the Calcutta Office were also compared and examined.

The necessary professional aid in connection with the protection of G. T. S. stations has been rendered by the Computing Section to the office of the Superintendent, Trigonometrical Surveys. 710 stations were repaired by district officers at a cost of ₹3,933.

An investigation was made by the Superintendent, Trigonometrical Surveys, of the azimuthal errors generated in the Principal Triangulation. For this purpose La Place's equation was formed at each of the Longitude Stations.

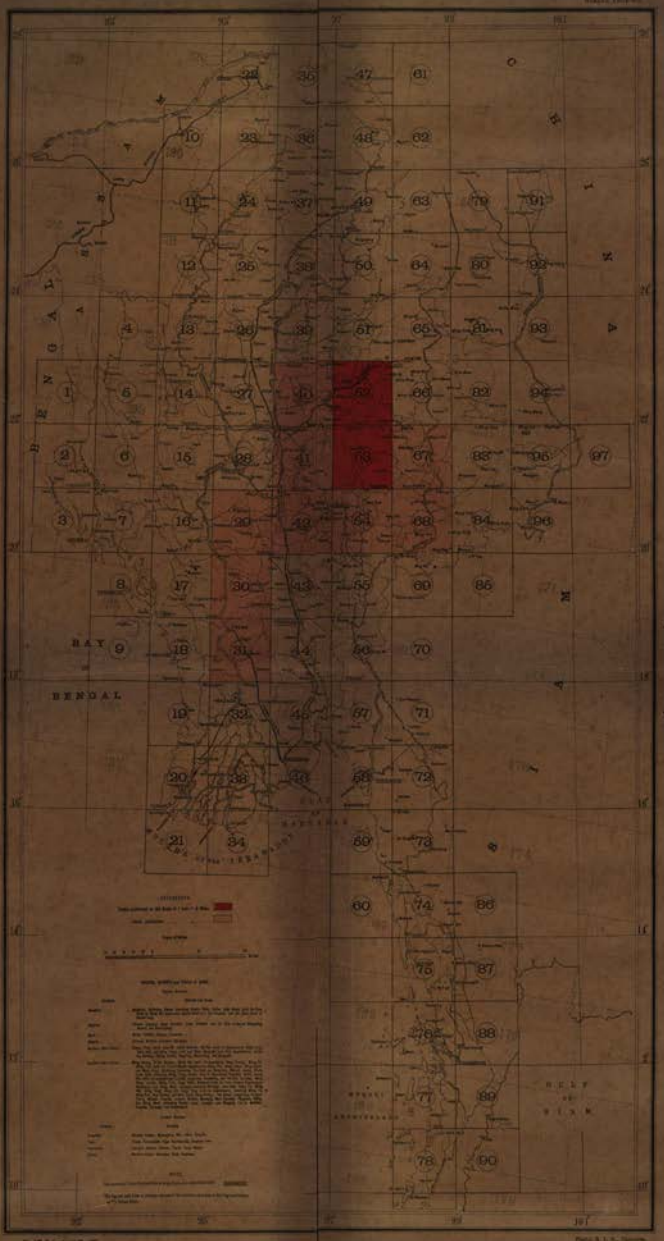
In the Drawing Section eighteen Tibet maps, one magnetic, one astronomical, five triangulation charts and one level sheet of Punjab were compiled and sent to press. Two sheets of India and Adjacent Countries on the scale of 1 to 1,000,000, numbers 62 and 70 and 4 level sheets are nearly ready for press.

Fifteen level sheets, eleven frontier maps, several diagrams for the Superintendent, Trigonometrical Surveys, and other maps are in hand. 2,746 maps were coloured.

Good progress was shewn in the work of the Photo.-Zinco. Section, 1,099 maps and diagrams being photographed against 864 and 85,066 pulls taken as against 57,464 in the previous year. The photo-helio section carried on its work as usual.

85. *Forest Surveys.*—The offices of the Forest Survey Branch were under the superintendence of the Superintendent, Forest Surveys, and were employed as usual on correspondence and Accounts, Computations, Area statements, the mapping of field surveys, the compilation of special Working Plans and other maps, the distribution of published maps and the upkeep of the Map Records of the Forest Department.

During the year 480 maps were sent to press and 497 were published at Calcutta, Dehra Dún and Poona.



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Fifteen thousand six hundred and twenty-two printed maps were distributed of which 8,476 were coloured and 3,142 mounted in book form. The work of this section of the office has been nearly doubled since the formation of the Forest Survey Branch.

A certain number of copies of each map published are now printed on cloth and these cloth maps have proved serviceable and convenient for use in the field.

During the year a sum of R409 was realised by the sale of maps, but the demand for Forest Survey maps by the general public is not a large one.

Among special maps compiled in this office were two of India on the scale of 48 miles = 1 inch, one showing all forests under Government control, and the other the progress of Forest Surveys and Working Plans.

LOCAL DRAWING OFFICES.

86. These continued the compilation of topographical maps at the following localities :—

87. *North-West Frontier Drawing Office, Mussooree.*—The main work of this office during the year has consisted in the fair mapping of 19 standard sheets of the North-West Trans-Frontier series and the South-West Asia series on the scale of ½-inch = 1 mile. Of these, 4 sheets have been submitted for publication and 9 for the preparation of cyanotype proofs, which will be sent to the military authorities for the classification of roads, and 6 are still in hand.

Personnel.
Mr. R. R. Dickinson, Extra Assistant Superintendent, 1st grade, in charge.
Mr. W. J. Cornelius, late Extra Deputy Superintendent (retired).
Mr. F. E. Warde, Sub-Assistant Superintendent, 1st grade.
1 Surveyor, 13 draftsmen, 1 writer, etc.

One sheet of the Northern Trans-Frontier series on the scale of ½-inch = 1 mile has also been prepared and submitted for publication. Good progress has been made with the "Map of India and Adjacent Countries," scale $\frac{1}{1,000,000}$. Four of the five sheets of this map which were begun last year have been completed, the fifth is in hand, and work has been commenced on a sixth. The map of Turkestan, scale 1-inch = 32 miles, has been projected, and work is in progress on the two Northern sheets.

The miscellaneous work has included the entry of Major Wanliss' route surveys in 7 of the ½-inch sheets and 3 of the ⅛-inch sheets of the North-West Trans-Frontier series, other additions and corrections to 4 of the ½-inch sheets of the same series, and the colouring and examination of a large number of maps, index charts, etc.

The total cost of the office during the year has been R23,380-6-4.

88. *Bangalore Drawing Office.*—The compilation of the degree sheet maps of Burma from the 1-inch standard maps of the topographical parties was continued. Sheets Nos. 29 and 42 were completed and submitted to head-quarters for publication Sheets 31, 54 and 67 will be completed before the end of 1905 and sheets 30 and 68, for which complete materials are available, are in hand. Sheets 27 and 28 have also been commenced, but materials are not available at present to quite complete them. Full materials will be available next season for the preparation of sheets 16 and 28.

In addition to the above, four 1-inch standard sheets of Burma are being re-drawn in the new form for publication in 4 colours, Nos. 242-E., 243-E., 244-E. and 195-W. and sheet 339 has been re-drawn in the old form for publication in 2 colours. A special map in 3 sheets has been prepared on the 1-inch scale of the road from Bhamo to Tengyueh and additions have been made to sheets 22 S.-E. and 23 N.-E. of the North-East Trans-Frontier series on the ½-inch scale. The special map of the Burma-China Boundary Commission, southern party, published in 1900 has also been brought up to date.

89. Local drawing offices at the following centres, carried on as usual the compilation of 1-inch standard maps from cadastral surveys, *i. e.*, one at Naini Tal in the United Provinces, one in Bengal at Calcutta and a third in Assam at Shillong. The work done by these offices is contained in part II of this report.

ESTABLISHMENT.

During the year, the Department lost the services of two of its most valuable officers by the superannuation of Colonel J. R. Hobday, I.A., and the retirement of Colonel R. A. Wahab, C.B., C.M.G., C.I.E., R.E., on account of ill-health.

Colonel Hobday was the last Imperial officer appointed to the Department before the amalgamation of the three branches in 1878. Having served with the 2—25th King's Own Borderers and the 38th Regiment, Bengal Infantry, he was appointed to the Survey of India on the 11th September 1874 and was attached to Central India Survey as Assistant Superintendent until 1878 when he proceeded on furlough. He was recalled in December of that year for service in Afghánistán and was attached to the Kandahár Column as Survey Officer. In December 1879 he was invalided and on rejoining in April 1881 he was attached to the Gujarát Survey under Colonel Haig. In November 1883, he organized and took charge of a party for the survey of the Andaman Islands, on the completion of which he was placed in charge of the Survey detachments attached to the Upper Burma Field Force and conducted the Survey operations with great skill and energy under exceptionally difficult circumstances and was specially commended for the excellent services he rendered to the Intelligence Branch of the Quarter Master General's Department and these were signalised by his appointment to a Brevet Majority. From 1891 to 1897 he was employed on survey work in the Bombay Presidency and worked up his party to a high state of proficiency. He was transferred in February 1897 to the Head-Quarters Office, Calcutta, as Assistant Surveyor General and subsequently officiated as Deputy Surveyor General from 19th April to 9th November of that year, and from 27th May to 3rd September 1898 when he was confirmed in that appointment. He also officiated as Surveyor General from 9th November 1904 to 3rd May 1905.

For his services in the field he received the Afghán and the Burma medals, he was mentioned in despatches and received a Brevet Majority.

Colonel Hobday was an excellent officer, few men have the thorough knowledge of practical surveying and power of executing surveys of all classes more highly developed in them than he had. He was an accomplished draftsman and of an enthusiastic temperament which communicated itself to his assistants and did much to keep them going under most trying circumstances, especially during the period immediately following the annexation of Upper Burma when an encouraging strong personality was necessary to keep the men at work.

Colonel Wahab joined the Department on 8th January 1883. Except for short periods when he was attached to a cadastral party and the Head-Quarters Office, Calcutta, he was employed on frontier surveys throughout his service. He served during the first Afghán War from January to June 1879 as Assistant Field Engineer and Adjutant, Royal Engineers, Peshawar Valley Field Force, and during the second campaign from October 1879 to August 1880 as Assistant Field Engineer. He was attached to the expedition against Mahsud Waziris during April and May 1881 as Assistant Field Engineer and in charge R. E. Park. During 1883-84 he accompanied Sir R. Sandeman's Mission to Khasan and Panjgur; in 1884 he was with the Zhob Valley Expedition as Survey Officer. In 1888 he was attached to the Hazára Field Force; in 1891 he served as Survey Officer with the Miranzái and Hazára Field Forces; in 1892 he was with the Isazái Field Force. During 1897-98 he was employed with the Tirah Expeditionary Force, where he was latterly Chief Survey Officer. From December 1901 to June 1904 he served as British Commissioner with the Aden Boundary Delimitation Commission.

Colonel Wahab was appointed Deputy Surveyor General from 16th July, but owing to ill-health he could not come out to take up the appointment. He was an enthusiastic and accomplished surveyor; his services on the North-West Frontier are quite exceptional and his retirement is a serious loss to the Department at the present time. For his services prior to 1901 he received the Afghán medal and both the Frontier medals with clasps and the Companionship of the Indian Empire, while his work in connection with the Aden boundary delimitation has been rewarded by his being gazetted a C.B. and C.M.G.

The following were appointed during the year: Lieutenant M. N. Mac-Leod, R.E., and Lieutenant F. F. Hunter, I.A.

90. In the Provincial Service the Department has lost the services of seven officers during the year by the retirement of Messrs. C. H. Mc A'Fee, J. McHatton, J. Bond, T. H. Dunne and S. O. Madras, by the death of Mr. E. F. Berkeley and by the resignation of Mr. H. I. Rice.

91. Six additional appointments in the Imperial service and twenty in the Provincial service have been sanctioned, the latter to be filled up in two years.

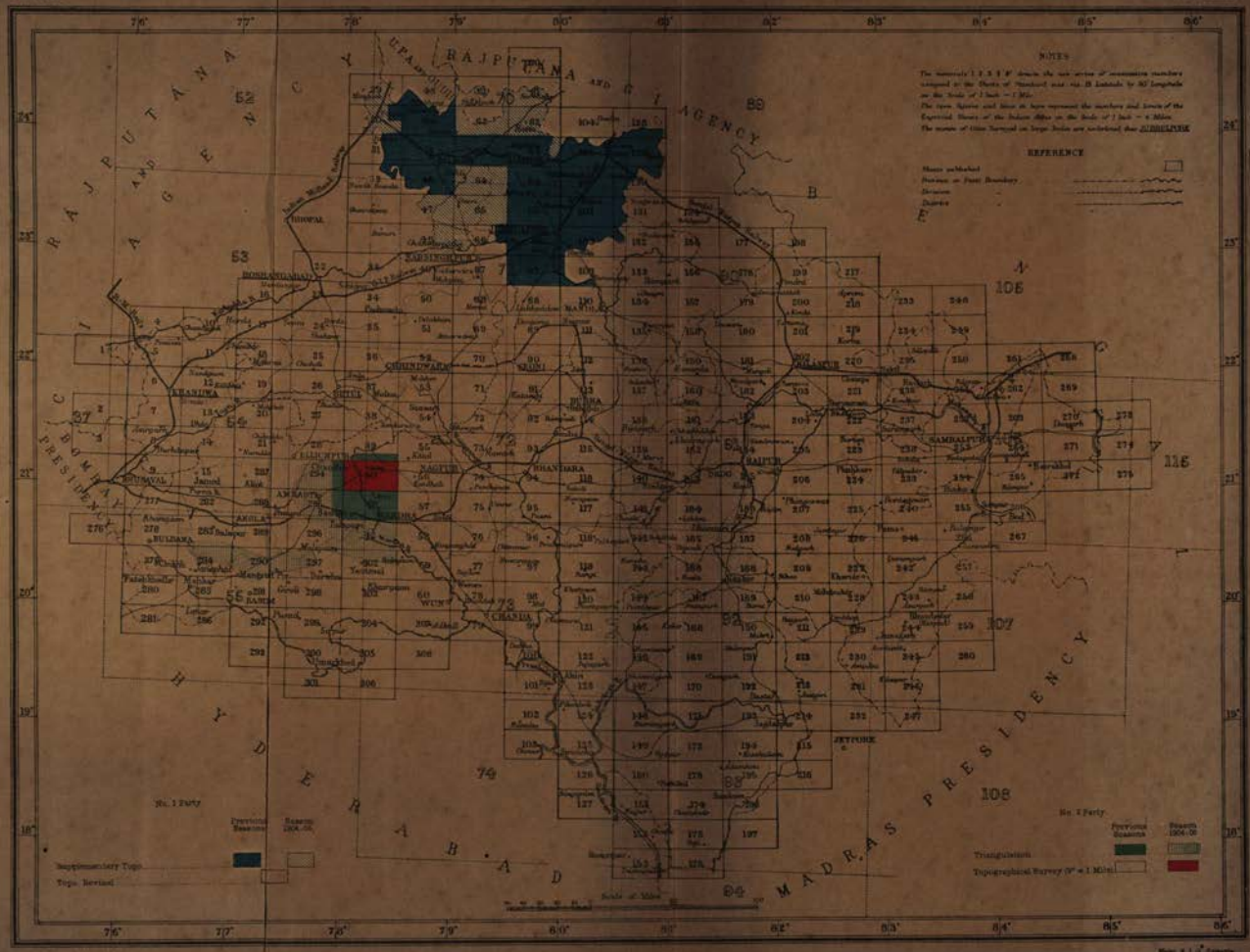
92. During the year under report an ex-officer of the Department, Colonel J. Waterhouse, I.A., was deputed as a representative of the British Government at the St. Louis Exhibition and he has contributed a very valuable report on matters affecting surveys which will have been published under the orders of the Government of India before this report sees daylight.

CENTRAL PROVINCES.

INDEX TO SURVEYS.

1904-05.

No. 1 PARTY.
No. 2 PARTY.



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PART II.

THE OPERATIONS OF FIELD PARTIES.

TOPOGRAPHICAL SURVEYS.

CENTRAL PROVINCES.

No. 1 Party.

93. The operations were in continuation of those of former seasons, and consisted of a supplementary topographical survey of maps compiled on the scale of 2 inches to a mile from cadastral surveys executed by local agency and based on traversing carried out by the Survey of India. No triangulation was done. The cadastral maps were reduced by pantagraph and the details which were entered on the plane-table sections in blue were examined and supplemented where necessary. The area thus surveyed during the season is 2,719 square miles and consists of the Central Provinces portions of sheets 29, 30, 47, 48, 61, 62, 81 and 82, the Central India portion of sheet 83 and the whole of sheets 64 and 65.

Personnel.

Captain A. H. B. Hume, R.E., Deputy Superintendent, 2nd grade, in charge, except while on examination leave, from 4th December 1904 to 18th March 1905.
Mr. W. M. Kelly, Extra Assistant Superintendent, 1st grade, in charge, from 4th December 1904 to 18th March 1905.
Mr. B. M. Berrill, Sub-Assistant Superintendent, 1st grade.
Munshi Ikbaluddin, K. S., Sub-Assistant Superintendent, 1st grade.
Mr. F. C. Glass, Sub-Assistant Superintendent, 3rd grade.
37 Surveyors, computers, draftsmen, etc.

94. Field work commenced on the 24th October 1904 and closed during the early part of May. The field season was generally a healthy one. The country in sheets 29 and 30 was for the most part flat and open, with a good deal of land that has gone out of cultivation and is now covered with grass. The ground in the rest of the sheets was generally hilly and covered in places with forest or scrub jungle. The valley of the Nerbudda river in sheet 48 is well cultivated, but the immediate vicinity of the river is cut up by ravines covered with short thorny jungle which impeded progress considerably. The average daily outturn per man was 0·6 square mile, and the cost rate ₹12·8 per square mile, which is slightly higher than that of last season owing to the scattered nature of the work and to the time spent by the surveyors in examining the Forest Survey maps as explained below.

95. An area of 866 square miles of reserved forests falls into the sheets that were surveyed this season and is not included in the above outturn. These forests had been surveyed in recent years by the Forest Department on the scale of 4 inches to a mile, and the maps were reduced by photography to the 2-inch scale, and the details entered on the plane-table sections. These details were in some instances examined to a certain extent by the surveyors who did the survey of the adjoining tracts, and in others were tested by the supervising staff, and the work generally found correct, but a thorough examination of the larger forests was not made.

96. The traversing of forest excisions and scattered villages was continued as called for by the local authorities, and 25 plots were traversed enclosing an area of 32 square miles in the Chánda and Hoshangabad districts.

97. The mapping of standard sheets on the 2-inch scale for publication on the scale of 1-inch to a mile has been completed as far as possible, but owing to various alterations that were introduced after the close of field work in the form and graticule of the standard maps, in accordance with the recommendations of the Survey Committee, most of the sheets surveyed this season require additional work in the field; consequently it was only possible to submit to headquarters for publication 2 sheets of the present season's work which are both in the new form, Nos. 64W and 65W. All 1-inch standard maps will in future be published in 4 colours, in the form of 15-minute squares, the graticule being brought into accordance with the latest value of the longitude of Madras.

98. Seven sheets, Nos. 43, 44, 46, 105, 109, 128, and 129, which were only partially surveyed last season, as topographical maps of portions of them were already in existence, have been completed this season by office revision of the old work and will be published as preliminary editions. The system of office revision which was described in para. 165 (2) of the report for 1902-03 was strongly condemned by the Committee and has been found to be extremely unsatisfactory in practice. It has therefore been discontinued, and in future any old topographical work falling into sheets under survey will be thoroughly revised in the field or re-surveyed.

99. In addition to the standard sheets, a map of Jubbulpore district has been prepared on the scale of ½ an inch to a mile for publication on half the scale in 2 colours. The preparation of district maps will now be discontinued and degree sheet maps will be prepared instead, as soon as sufficient reliable material is available.

100. Combined triangulation and traverse charts are being prepared by this party on the 1-inch scale for publication on the ½-inch scale. As such charts have not been prepared hitherto, one sheet only was completed and submitted as a specimen for the approval of the Surveyor General.

101. The programme for next season consists of the supplementary survey on the 2-inch scale of cadastral and forest maps in sheets 66 and 67, and in the United Provinces portions of sheets 43 and 44, while a re-survey will be made of the portions of sheets 29, 30, 31, 32, 46, 47, 48, 61, and 62 which are exterior to the Central Provinces. The composition of the party has, however, undergone considerable changes and a large number of men have been attached to it for training with a view to eventual employment in the frontier parties and it is possible this large programme will not be completed.

102. The party was inspected by the Surveyor General during the recess and during both the field and recess seasons by the Deputy Surveyor General.

BERAR.

No. 2 Party.

103. The party was newly formed this season for the further training of junior officers of the Imperial and Provincial services after they have undergone preliminary training at the Dehra and Bangalore training schools. A topographical survey of Berar on the scale of 2 inches to the mile based on triangulation will be carried out at the same time. Progress will be necessarily slow, the chief object aimed at being the training of the officers in correct methods and accurate work. Although the number now assigned to this party was formerly borne by the double party employed on cadastral surveys in the United Provinces, there was no transfer of establishment or records.

Personnel.

Captain E. T. Rich, R.E., Officiating Deputy Superintendent, 2nd grade, in charge to 10th September 1905.

Mr. C. F. Erskine, Officiating Superintendent, 2nd grade, in charge from 11th September 1905.

Lieutenant H. S. May, R.E., Officiating Assistant Superintendent, 1st grade.

Lieutenant M. N. MacLeod, R.E., Assistant Superintendent, 2nd grade.

Mr. W. A. Fielding (retired and temporarily re-engaged), Assistant Instructor and 5 Sub-Assistant Superintendents on probation, 1 computer and 1 clerk.

104. Field work commenced on the 1st October 1904. The triangulation included a minor series emanating from the side Pilkher P. S.—Kopdi H. S. of the Great Are meridional series of the Great Trigonometrical survey which, running westwards through sheets 297, 290, 284 and 279, will eventually close on the Khánpisura meridional series. The distance is about 120 miles, of which about 70 were covered by this season's work. The area triangulated during the season is 1,690 square miles and comprises the whole of sheet 42 and portions of sheets 294, 295, 296 and 302. The whole area required very careful preliminary reconnaissance, as it was devoid of prominent features everywhere, while in places it was flat and thickly wooded and the triangulation was carried out with considerable difficulty. The average number of square miles to each point trigonometrically fixed is 3·6.

105. The detail survey of one sheet only, No. 40, was completed, the area surveyed being 483 square miles. The greater portion of this sheet lies in the Wardha district, in which were some reserved forests which had previously been surveyed by the Forest Department on the 4-inch scale covering an area of about 72 square miles. Similar forests occur in the Berar portion, but they had not been surveyed previously and have now been done on the 2-inch scale by this party at the request of the Forest Department. Field work ceased on the 30th April 1905. The average monthly outturn of plane-tabling per man was 19·3 square miles and the average per working day 0·7. The country surveyed consisted of the level bed of the Wardha river, which is open and cultivated, with groups of trees dotted about, and flanked on both sides by low bare hills rising to a height of 200 to 400 feet, and presented no difficulty to the survey which was carried out entirely by interpolation.

106. The party was inspected by the Deputy Surveyor General during both the field and recess seasons. Neither the mapping nor computations were completed during the recess owing to the urgent demand for officers in other parties which necessitated the transfer of one Imperial and two of the Provincial officers at the commencement of the recess. In addition to the standard mapping a combined triangulation and traverse chart was prepared of sheet 40 on the 1-inch scale for reduction to half.

107. Next season the triangulation of sheets 294, 295 and 296 will be completed and that of sheets 28 and 39 taken up. The secondary series commenced this season will also be completed and sheets 41 and 295 will be surveyed in detail, including all reserved forests which have not already been surveyed, while the maps of those that have, will be tested and supplemented to meet the requirements of the Forest Department.

LOWER BURMA.

No. 3 PARTY.

108. The work of this party consists of a topographical survey on the scale of 1-inch=1 mile based on triangulation, combined with a supplementary topographical survey of such areas as have been surveyed cadastrally. The season's outturn and cost rates are as follows:—

Personnel.

Mr. E. F. Litchfield, Deputy Superintendent, 1st grade, in charge.
Mr. W. M. Gorman, Extra Assistant Superintendent, 6th grade.
Mr. J. O'B. Donaghey, " " " " "
Mr. E. Claudius, Sub-Assistant Superintendent, 1st grade.
Munshi Asmatulla Khan, " 2nd "
Mr. H. D. W. Stotesbury, " 3rd "
18 Surveyors, 6 computers, draftsmen, etc.

	Square miles	R
Triangulation	1,218	24·9 per square mile.
New detail survey	2,078	23·9 " " "
Supplementary survey	425	18·0 " " "

The triangulation was confined to a narrow strip of country on the eastern margins of sheets 302 to 307 and the adjoining portion of sheet 351, as the greater part of these sheets has been surveyed cadastrally and will come under supplementary survey. The number of square miles to each point trigonometrically fixed is 9. The traversing of the cadastral survey was connected with the present triangulation which was also supplemented by 53 linear miles of simple traversing, giving 498 extra points of which the heights of 434 were determined.

109. The sheets that came under detail and supplementary survey are the whole of 298, 299 and 300 and portions of 251 and 252, the two latter of which had been partially surveyed topographically on the scale of 4 inches to the mile in 1903 to 1905 by the Forest Survey Branch. The supplementary survey was done on "tracing prints" prepared by pasting bankpost paper over printed copies of the maps compiled from the cadastral survey, a convenient and expeditious method when the area for supplementary survey is extensive and the survey is done on the same scale as the maps, as the labour of tracing the details on to the plane-table sections is avoided.

110. The field season was slightly curtailed this year on account of the arrears of mapping still remaining. The recess office at Bangalore closed on the 16th November 1904 and re-opened on the 11th May 1905 but the time actually occupied on field work was barely 4½ months. The number of surveyors was 19 and the average outturn *per* man *per* working day was 1·3 square mile of new detail survey and 2·0 of supplementary. The average number of plane-table fixings per square mile was 4·8 for new survey and 15·8 for supplementary. In sheets 251 and 252 a vertical interval of 50 feet was employed for the contouring but elsewhere the interval was extended to 100 feet.

111. The Paunglaung range of hills, the eastern watershed of the Sittang river, runs right through the season's work and forms a distinct dividing line between two widely differing varieties of ground. The western slopes are covered with a dense growth of bamboo and intersected with innumerable watercourses necessitating a good deal of clearing and the constant use of the chain. On the eastern side, plane-tabling was comparatively easy as the hills are bold and bare-topped though the lower slopes and valleys are well wooded. The health of the party during the field season was on the whole good. The hills are infested with a small fly that possesses a peculiarly virulent sting and gave a good deal of trouble last season and the *khalasis* were therefore provided on this occasion with what are called Jodhpur breeches and spats to protect their legs and feet, a precaution which amply repaid the expenditure incurred.

112. The cost-rate for the triangulation this season is high, owing partly to the small area triangulated, but it includes observations made at 3 stations for the purpose of connecting the traversing of the cadastral survey with the present operations, to which no area can be credited. The rates for new detail and supplementary survey differ but little from last season's but are slightly higher for which no particular reason can be assigned.

113. A considerable advance has again been made with the arrears mapping and the following 12 sheets were submitted to head-quarters for publication, Nos. 75, 76, 113 to 116, 157, 158 and 211 to 214. Two others, 206 and 207, were almost completed at the close of the recess and only two, Nos. 204 and 205 of the old arrears mapping remain unfinished and they are well advanced. The maps of the current season's work are being drawn in the new form, 15 minutes square and have all been completed with the exception of 3 sheets, 298, 299 and 300, of which a strip along the eastern margin remains to be surveyed owing to the change in graticule which is to be introduced with the new form of maps. Two triangulation charts of degree sheets 18N and 18S were submitted for publication and three others, 30N, 30S, and 43N, are in hand.

114. The programme for next season consists of the triangulation of sheets 347 to 350 and 394, 395 and 397 (which has been substituted with the approval of the Government of Burma for the original programme) and the detail survey of sheets 301 to 306.

115. The Survey Committee visited this party during the field season and inspected two plane-tablers at work and the Deputy Surveyor General inspected it during the recess.

UPPER BURMA.

No. 10 Party.

Personnel.

Captain C. P. Gunter, R.E., Assistant Superintendent, 1st grade, in charge to 31st May 1905.
Captain E. T. Rich, R.E., Assistant Superintendent, 1st grade, in charge from 1st June.
Mr. R. Waller-Senior, Extra Assistant Superintendent, 3rd grade.
Mr. P. J. Barrington, Extra Assistant Superintendent, 4th grade.
Mr. W. G. Jarbo, Sub-Assistant Superintendent, 1st grade.
Mr. C. West, Sub-Assistant Superintendent, 2nd grade.
Mr. R. M. Kenny, Sub-Assistant Superintendent, 2nd grade.
Munshi Abdul Rahim, K.S., Sub-Assistant Superintendent, 3rd grade.
21 Surveyors.

116. The party is employed in the same way as No. 3, but this season the work was all supplementary survey. One native Provincial officer and 3 Surveyors were employed during part of the season on reconnaissance surveys in connection with two separate expeditions despatched, one to determine the Burma-China boundary and the other to mark it out where it had already been determined.

1904-05. BURMA. TOPOGRAPHICAL SURVEYS

Reg. No. 993-S. 08.

BURMA.

Photo. S. L. O., Calcutta.

Reg. No. 994-S. 06.

117. The programme was completed and the outturn and cost-rates of the ordinary work of the party for the season are as follows :—

		Outturn.	Cost-rates.
Triangulation .	. Square miles	3,912	R 6·9 per square mile.
Supplementary survey	„ „	3,940	„ 16·9 „ „ „

The triangulation occupied three Provincial officers for an average of 5 months each and one Sub-Surveyor for 3. It covered the whole of sheets 71 to 74 and 106 and portions of 104, 105 and 107. The greater part of sheets 71 to 74, representing about half the area triangulated, was mountainous and wooded, necessitating a good deal of clearing but not otherwise difficult. The rest was open and easy ground where cadastral operations were in progress or had just been completed, with low bare hills rising here and there in detached groups.

118. The detail survey embraced the whole of sheets 148 to 150, 196 and 197 and the western halves of 194, 242, 243 and 244. The average number of plane-table fixings was 7 per square mile. The plane-table sections of 5 sheets were prepared for supplementary survey by entering on them in blue the details traced from the 1-inch standard maps which had been compiled from the cadastral survey, while "tracing prints," as described at paragraph 109 of this report, were used for the rest. Field work was actually in progress for close on six months, and the party was away, from recess quarters from the 19th October 1904 to the 5th of May 1905. The number of plane-tablers was 22 and the average outturn of supplementary survey per man per working day was 1·48 square mile.

119. The cost-rates are considerably lower than those of last season when the work nearly all consisted of supplementary survey also. This is due to the easier nature of the country surveyed this year and the larger outturn and also to the fact that no distinction was made this season between wet and dry cultivation.

120. For various reasons, among which may be mentioned the unfinished state of Mr. Walsh's triangulation last season when he fell ill, the computations have fallen into arrears. Triangulation charts of degree sheets 27S and 28N were submitted for publication, and those portions of sheets 40S and 41N which had been triangulated by this party were drawn and the charts handed over to No. 11 Party for completion. Charts of sheets 16N, 16S and 28S are in hand. The standard maps of the season's work were all drawn in the new form of 15 minutes square with graticules adjusted to the latest adopted value of the longitude of Madras, with the exception of sheet 194, of which half was surveyed and drawn last season in the old form, and this form was consequently retained. Sheet 193 which had been drawn and nearly completed last season in the old form was completed and forwarded to head-quarters. The eastern half of sheet 195 was redrawn in the new form to avoid a gap between it and sheet 242. Of the present season's work only 3 sheets were submitted for publication, Nos. 194, 196 and 197. The rest will be completed in the Bangalore Drawing Office and should be submitted shortly.

The party was inspected by the Deputy Surveyor General during the recess.

121. The programme for next season is the triangulation and traversing where necessary of sheets 142 to 145 and 189 to 191 and the detail survey of sheets 71 to 74, 109 and 152.

122. The reconnaissance work done on the Burma-China boundary during the season was—

	Square miles.
Triangulation	1,950
Detail survey on the scale of 1-inch to the mile . . .	1,070
„ „ „ ½ „ „ „ . . .	2,970

One Sub-Surveyor was employed on this work throughout the field season and one native Provincial officer and 2 Surveyors for about two months. The air mapping of this work is being done in the Bangalore Drawing Office and details regarding it will be found in the report of that office at page 20. The ½-inch survey was done in connection with the determination of the Burma-China boundary to the north-east of Bhamo and 810 square miles of the 1-inch survey was done in connection with the demarcation of another portion of the boundary

which had been previously determined. The rest of the 1-inch work, 260 square miles, consisted of a survey of the road from Bhamo to Tengyueh (Momien).

NORTH-WEST FRONTIER.

No. 11 Party.

Personnel.

Major J. M. Burn, R.E., Officiating Superintendent, 2nd grade, up to 22nd October.
Lieutenant C. M. Browne, D.S.O., R.E., Assistant Superintendent, 2nd grade, in charge up to 23rd May.
Lieutenant R. H. Phillimore, R.E., Assistant Superintendent, 2nd grade, in charge from 23rd May.
Babu Pramadaranjan Roy, Sub-Assistant Superintendent, 1st grade.
Mr. H. C. Stotesbury, " " " 1st grade.
Mr. V. W. Morton, " " " 2nd grade.
Mr. A. B. Hunter, " " " 2nd grade.
Mr. P. Simpson, " " " 2nd grade.
19 Surveyors and probationer surveyors.

123. Lieutenant C. M. Browne, D.S.O., R.E., took over charge of No. 11 Party on 23rd October 1904, and on 23rd May 1905 handed over to Lieutenant R. H. Phillimore, R.E., who remained in charge till the end of the year.

124. The party arrived at Quetta from Bangalore during the last week of October, and received orders to co-operate with No. 15 Party in carrying out work on the 2-inch scale in Baluchistán and Waziristán.

125. No triangulation was available in Waziristán, so detail survey was confined to Baluchistán during November and December, while triangulation was pushed on as rapidly as possible in Waziristán. In January after the completion of 283 square miles of revision survey on the 2-inch scale in an area some 30 miles south-west of Quetta, the bulk of the party was moved to Waziristán, and took up work near Bannu. Mr. V. W. Morton and five surveyors were left to continue the work in Baluchistán, where an area of 44·5 square miles was surveyed by the close of the field season in June. The work of this detachment was suspended for two months in winter owing to severe weather.

126. By the middle of January the triangulation in Waziristán was sufficiently advanced to enable the detail survey to begin, and an area of 214 square miles in the Bannu district was distributed among the plane-tablers. As each man completed the survey of his section, he was moved to the Tochi valley where most of the plane-tablers were employed by March. Work was carried on till May 15th, when it was closed owing to opposition on the part of the tribesmen, after the completion of 325 square miles in the Tochi valley.

127. Both in the country near Bannu and in the Tochi valley, guards were required during the whole period of the operations, and during the last fortnight, work on several plane-tables had to be stopped as the surveyors could not be permitted to go to their work.

128. The triangulation in Baluchistán was carried out by Mr. Morton who completed an area of 506 square miles. Two triangulators, Babu Pramadaranjan Roy and Mr. H. C. Stotesbury, were employed in Waziristan, their united outturn amounting to 891 square miles.

129. The outturn of the party during the season under report consisted of—

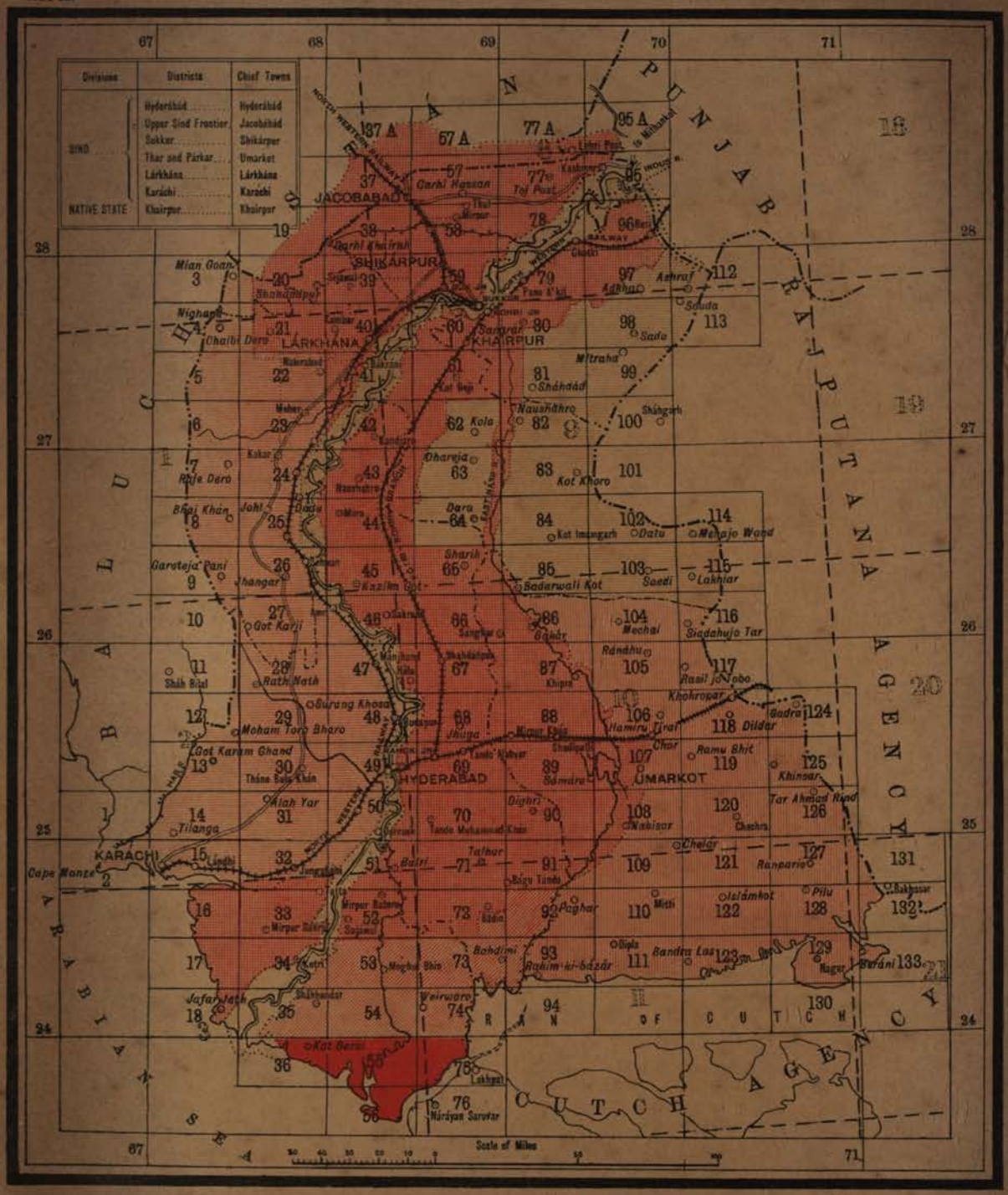
Triangulation	1,396·9	square miles.
Detail survey on the 2-inch scale	981·66	" "

The cost-rates were:—Rs. 24-8-0 per square mile for triangulation and Rs. 64-7-5 for detail survey.

130. During recess the fair drawing of two Baluchistán sheets, Nos. 332-S.E. (3) and 345-N.E. (1), and of four Waziristán sheets, Nos. 442-S.E. (1) and (3) 443-N.E. (1), and 443-N.W. (2) was completed up to the limits of survey. The former were drawn on the 2-inch scale for reproduction, and the latter on the 2-inch scale for reduction to the 1-inch scale. Sheets 442-S.E. (1) and (3), 443-N.E. (1) and 442-N.W. (2) will be published as preliminary editions, and the other sheets will be retained in the North-West Frontier Drawing Office for additions which will be surveyed in 1905-06.

SIND SURVEY.

1904-05.



Reduced and printed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, December 1906.

No. S. S. I. 11-12-1906-250

REFERENCES.

Surveyed in Previous Seasons Scale 8" = 1 Mile	
Do. do. 1" = 1 Mile	
Do. do. 2" = 1 Mile	
Do. do. 4" = 1 Mile	
Indus Riverain Survey 1" = 1 Mile	
Surveyed in 1904-05 1" = 1 Mile	
Do. 1904-05 2" = 1 Mile	
Triangulated in advance	

Reg. No. 1310-S. 05.

NOTES.

The numerals 63, etc., indicate the Standard sheets on the Scale 1 inch = 1 Mile.
The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

131. The health of the party was good on the whole. There were three deaths from pneumonia and several cases of scurvy in the menial establishment.

132. In October 1905 No. 11 Party was reduced in strength to 1 Imperial officer, 2 Provincial officers, and 12 surveyors, and returned to the Southern Shan States to resume the 1-inch survey beyond the Salween river, in standard sheets 564, 565, 566 and the western half of 604. Sheets 606, 607 and 608 will be triangulated in advance for detail survey in the following year. The party will in future recess in Burma.

SIND.

NO. 12 PARTY.

133. Mr. C. F. Erskine was in charge till the 31st August 1905, when he was transferred to No. 2 Party (Berar) and Mr. R. F. Warwick took over charge of the party for the remainder of the year.

Personnel.

Mr. C. F. Erskine, Officiating Superintendent, 2nd grade, in charge up to 31st August 1905.
Mr. R. F. Warwick, Extra Assistant Superintendent, 3rd grade, in charge from 1st September 1905.
Munshi Rahmatullah, Extra Assistant Superintendent, 5th grade.
Mr. E. C. J. Bond, Extra Assistant Superintendent, 6th grade.
Mr. H. A. Charrier, Sub-Assistant Superintendent, 1st grade.
Babu Dhani Ram " " "
Mr. R. E. M. Saubolle " " 2nd "
30 Surveyors, computers, draftsmen and writers.

The survey operations were of the same nature as in former years and the following programme was completed :—

(*a*) Net-works of secondary triangulation over the Thar and Parkar districts in sheets 92, 93, 108, 109, 110, 111, 120, 121, 122, 123, 126, 127, 128, 129, 130, 131, 132 and 133 covering an area of about 7,775 square miles.

(*b*) Detail survey on the 2-inch scale in sheets 34, 35, 53, 54, 72, 73, 74, 92, 93 and 94.

(*c*) Detail survey on the 1-inch scale in sheets 36, 55, 56, 75 and 76.

(*d*) Traversing and detail survey of 13½ square miles on the 12-inch scale in extension of the Karachi Cantonment Survey.

(*e*) A line of traverse along the railway from Badin Railway Station to Hyderabad Fort.

134. The area surveyed in detail on the 2-inch scale amounts to 2,787 square miles and that on the 1-inch scale to 1,150 square miles, the work was tested by 999 *in situ* fixings and was carried out under the direct supervision of the officer in charge.

The cost-rates for survey and fair mapping are—

		₹	a.	p.
Scale 2-inches = 1 mile	. . . . .	13	14	4
" 1-inch = 1 mile	. . . . .	6	14	4
" 12-inches = 1 mile	. . . . .	507	3	0

Work in the field was closed by the end of March 1905, and the party returned to Karachi for recess.

135. During recess the fair mapping of the entire areas surveyed in detail on the 1-inch and 12-inch scales, and the greater portion of that on the 2-inch scale was completed. The mapping comprised 4 sheets on the 1-inch scale, 7 sheets on the 12-inch scale and 30 quarter sections on the 2-inch scale. The 1-inch and 12-inch sheets were drawn for reproduction, and those on the 2-inch scale for reduction to 1-inch.

All sheets on the 1 and 12-inch scales and most of the sheets on the 2-inch scale have been despatched to the Trigonometrical Survey Office, Dehra Dún, for publication, and the remaining sheets will be submitted shortly on completion of the drawing. The triangulation charts of the work of this party during the year under report, together with the list of points shown on the charts with the values of their co-ordinates, are being prepared and will be submitted to the Dehra Office.

136. During the ensuing field season the party will be employed on the North-West Frontier.

137. The health of the party during the field season was only fair, there being many cases of pneumonia; from this complaint four *khalasis* died in the field and two after the close of the field season.

The party was inspected by the Superintendent, Trigonometrical Surveys, during the field season.

UNITED PROVINCES OF AGRA AND OUDH.

No. 14 Party.

138. The party continued the topographical survey, on a scale of 2 inches to one mile, of the districts Allahabad, Fatehpur and Cawnpore. The survey of the first two districts is now complete. The field office opened at Cawnpore on 25th October 1904 and closed on 25th April 1905.

Personnel:

Captain H. L. Crosthwait, R.E., Deputy Superintendent, 2nd grade, in charge.
Lieutenant M. N. MacLeod, R.E., Assistant Superintendent, 2nd grade, from 1st June to 30th September 1905.
Mr. C. A. Norman, Extra Assistant Superintendent, 2nd grade, from 4th July to 20th September 1905.
Mr C. George, Extra Assistant Superintendent, 3rd grade.
Mr J. H. S. Wilson, Extra Assistant Superintendent, 6th grade.
Mr. E. J. Biggie, Extra Assistant Superintendent, 6th grade.
Mr. H. B. Simons, Sub-Assistant Superintendent, 2nd grade.
16 Surveyors, 13 surveyors under instruction, 6 computors, 10 draftsmen, 1 writer, etc.

139. The outturn of field work of the party for the season is as follows:—

Original 2-inch survey	1908·26	square miles.	
Revision survey	300·12	„	„
Supplementary survey	217·66	„	„
TOTAL	2,426·04	„	„

These areas were included in standard sheets Nos. 156, 167, 139, 138, 123, 107, 108, 109, 91 and 92 of the United Provinces series.

140. The origins of survey remained the same as reported last year.

141. In consequence of the employment of surveyors, who would otherwise have been engaged in fair mapping during the recess, on special duty in connection with the manœuvre map near Delhi, the drawing of the party is very much in arrears. Arrangements have been made to bring it up to date during the coming field season.

142. Owing to so great a proportion of the strength of the party consisting of men under instruction, and to the fact that very little of the area surveyed could be mapped, any cost rate that could be obtained for the work of the past year would be misleading.

143. The character of the country surveyed was of the same nature as that reported last year and calls for no further special remark.

144. The party, having been transferred to the North-West Frontier, will be engaged on special military surveys.

145. The Surveyor-General inspected the party in August 1905.

UNITED PROVINCES.

1904-05. INDEX TO THE SURVEY OPERATIONS No. 14 PARTY.

Published under the direction of Colonel H. H. Godwin-Austen, R.E., Surveyor General of India.

Survey of India Offices, Calcutta, Sept. 1905.

Lithograph 1905.

No. 255-S. 95

NORTH-WEST FRONTIER.

No. 15 Party.

146. Captain F. W. Pirrie was in charge of the party during the whole survey year.

147. The party continued to carry out special surveys for military purposes on the scale of 2-inches to 1 mile in Baluchistán, the North-West Frontier Province, and adjacent tribal territory.

Personnel.

Captain F. W. Pirrie, I.A., Deputy Superintendent, 2nd grade, in charge up to 14th September 1905.
Major C. L. Robertson, C.M.G., R.E., Deputy Superintendent, 1st grade, in charge from 15th September 1905.
Lieutenant R. H. Phillimore, R.E., Officiating Assistant Superintendent, 1st grade, up to 23rd May 1905.
Mr. J. McHatton, Extra Deputy Superintendent, 2nd grade, up to 16th July 1905.
Mr. G. A. Knight, Extra Assistant Superintendent, 1st grade.
„ J. A. Freeman, „ „ „ 5th „
Munshi Imam Sharif, „ „ „ 5th „ up to 6th October 1904.
Mr. H. C. H. Cooper, „ „ „ 6th „
„ D. J. Hunter, „ „ „ 6th „ from 1st September 1905.
Subadar Kanak Singh, Sub-Assistant Superintendent, 2nd grade.
Mr. E. B. West, „ „ 2nd „
„ P. Simpson, „ „ 2nd „ from 22nd August 1905.
Mr. E. C. O'Sullivan, „ „ 2nd „
„ E. A. Wainright, retired Provincial Officer.
„ J. McHatton, „ „ from 1st August 1905.
50 Surveyors, etc.

148. These surveys were temporarily interrupted during the field season by the change of the locality of survey and by unrest among the local tribes.

149. On the completion of the regular work for the year the survey of a small tract of country near Campbellpur, urgently required for an artillery practice camp, was taken up; also in conjunction with a detachment of No. 14 Party a survey on the scale of 1-inch = 1 mile was carried out for a military manœuvre map in the neighbourhood of Delhi. These surveys were carried out during the hot weather under trying conditions, and necessitated the retention of the surveyors employed on them in the field for a whole year.

150. The survey of cantonments and cantonment bazaars in the Punjab were continued by a detachment of the party under the supervision of Mr. McHatton, who introduced and satisfactorily carried out the system of preparing the field maps for reproduction without re-drawing. This enabled the special drawing section of the cantonment detachment to clear off all arrears of cantonment mapping.

The following cantonments with their bazaars were surveyed on the scale of 16 and 64-inches to 1 mile respectively :—

Siálkot.	Cherat.
Dera Ismail Khan.	Ráwalpindi.
Murree (partly).	

Mr. J. McHatton retired on pension after a year's extension of service in July 1905 but was re-employed shortly afterwards and remained in charge of the detachment for the remainder of the year.

Various trans-frontier reconnaissance and detail surveys were also carried out by members of the party for the Foreign Department.

151. The training in regular surveying of soldier surveyors who had previously been taught military surveying at Roorkee was continued and a certain proportion of their work was utilized in the fair mapping.

152. Owing to the want of suitable triangulation on which to base the 2-inch detail survey, a secondary series was carried out by Lieutenant Phillimore, R.E., and minor network triangulation by other officers who all computed their observation and prepared plane-tables therefrom for the detail surveyors, in the field.

153. The 2-inch survey on the North-West Frontier was done conjointly with No. 11 Party, the officer in charge of No. 15 Party being responsible for the general arrangements, distribution of work and methods of survey of both parties.

154. The party left Mussooree in the beginning of September 1904 and returned to recess about the end of May 1905.

The recess season of 1905 lasted only three months from the beginning of June to the end of August, as the party again left for the field during the first week of September.

With such short recess seasons it is absolutely necessary to employ a permanent drawing staff, in order to enable the mapping to keep pace with the field survey.

155. The compilation of the charts and volumes of the triangulation of Baluchistan was carried out in an able manner by Mr. E. A. Wainwright, late extra Deputy Superintendent, who was specially re-employed for the purpose, owing to his long service with the party and knowledge of its records and of the country. At the close of recess only a few charts and volumes remain incomplete and these should be finished before the end of the year.

156. The outturn for the year is as follows :—

Description of survey.	Area in square miles.	Cost per square mile.
		R. a. p.
2-inch survey (North-West Frontier).		
Secondary triangulation	2,193	5 0 9
Minor network triangulation	1,468	19 4 0
Detail survey	1,509	61 5 5
4-inch survey (Hatti Range).		
Minor network triangulation	100	11 7 6
Detail survey	75	107 8 0
Cantonment surveys.		
16-inch detail survey, including triangulation, traversing and arrears of mapping (cantonment plans).	25·458	853 2 6
64-inch detail survey including triangulation, traversing and arrears of mapping (cantonment bazaars.	0·567	8190 8 0

157. All members of the party co-operated loyally with the officer in charge and carried out their duties to the best of their ability.

158. The programme for the year 1905-06 consists of the continuation of 2-inch topographical surveys on the North-West Frontier.

159. The party was inspected by the Surveyor General during recess.

PUNJAB.

No. 18 Party.

160. Captain E. A. Tandy, R.E., remained in charge of the party up to the 1st of August, when he proceeded on leave and was replaced by Captain M. O'C. Tandy, R. E.

Personnel.

Captain E. A. Tandy, R. E., Deputy Superintendent, 2nd grade, in charge up to 1st August 1905.
Captain M. O'C. Tandy, R. E., Officiating Deputy Superintendent, 2nd grade, in charge from 2nd August 1905.
Lieutenant F. F. Hunter, I. A., Assistant Superintendent, 2nd grade, from 17th August 1905.
Mr. W. Robert, Extra Deputy Superintendent, 1st grade.
" G. J. S. Rae, Extra Assistant Superintendent, 5th grade.
" J. O. Greiff, " " " " "
" C. E. C. French, " " " 6th "
J. R. Newland, Sub-Assistant Superintendent, 1st grade.
Babu Maya Das Puri, " " " "
Mr. L. Williams, " " 3rd "
" F. C. Pilcher, " " " "
" A. G. Harrington, " " " "
" F. H. Grant, " " " "
71 Surveyors, etc., 6 soldier Surveyors.

Arrears Mapping Section.

Mr. C. E. Tapsell, Extra Assistant Superintendent and 25 draftsmen.

The originally sanctioned programme had to be very considerably modified on account of a special survey which the party was ordered to make for the military authorities; for this reason the area of supplementary 2-inch survey was much reduced; the district traverse work was also curtailed in order to further strengthen the riverain traverse section.

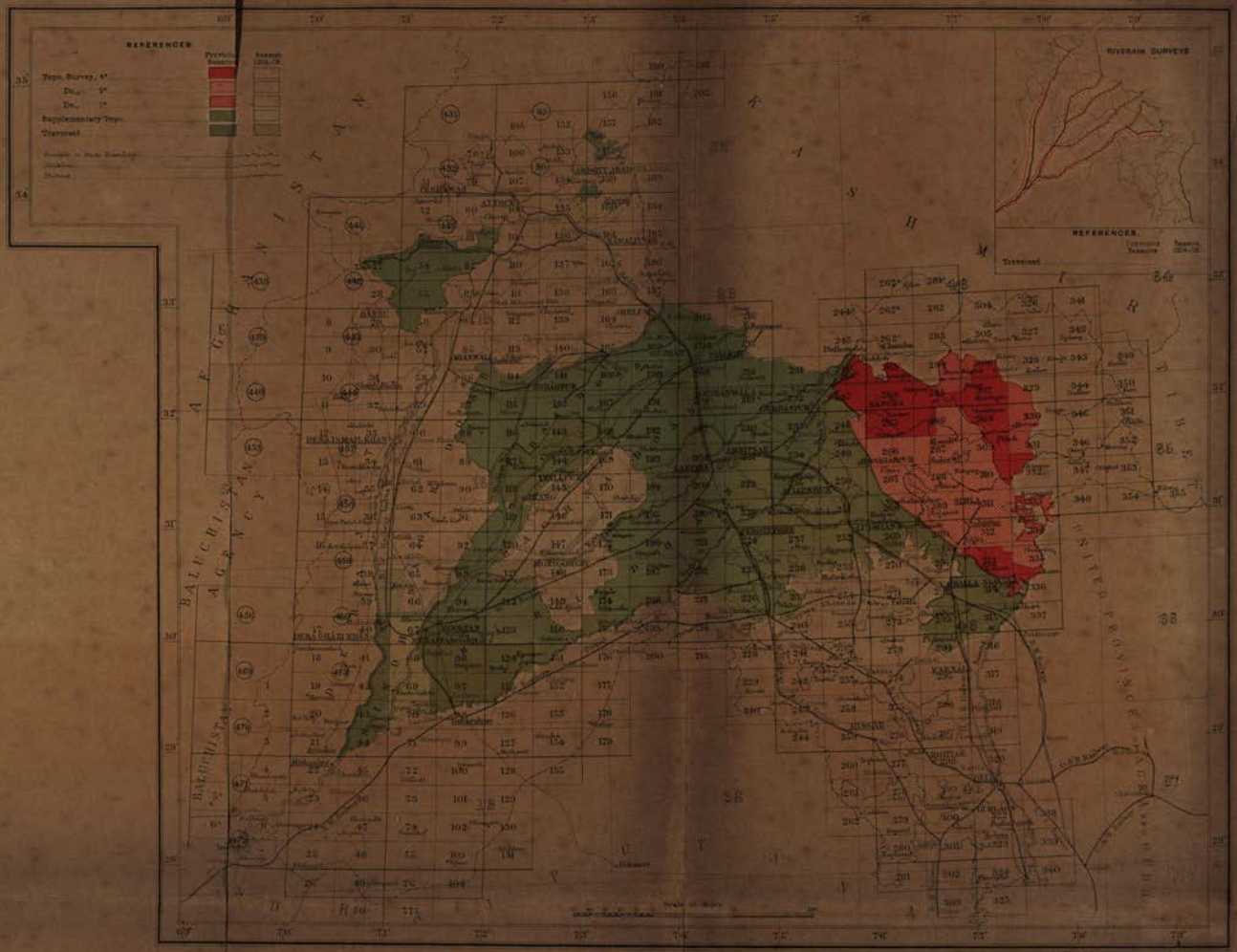
A drawing office consisting of two sections was maintained throughout the year at Simla, one section being employed on fair drawing the arrears of

PUNJAB & N. W. FRONTIER PROVINCE.

INDEX TO SURVEY OPERATIONS.

1904-05

No. 18 PARTY.



Published under the direction of Colonel H. R. Thuillier, R. E., Surveyor General of India.

Addressed to [illegible]

NOTES.

The numerals 1, 2, 3, 4, &c., denote the new copies of [illegible] [illegible] in the Sheets of standard size, viz., 15" [illegible] by 20" longitude on the scale of 1 Inch = 1 Mile.

The same figures and sizes in bars represent the numerals and sizes of the Engraved Sheets of the Indian Atlas on the scale of 1 Inch = 4 Miles.

The names of Cities Surveyed on large Scales are underlined thus. LAHORE.

The figures in circle refer to the Sheets of the N. W. F. P. Series.

Reg. No. 1040-S. 06.

Himalayan work, and the other those of the 2-inch supplementary survey miscellaneous drawing, which will be mentioned later, had also to be undertaken.

161. The field season commenced at the beginning of November and finished at the end of May, but a strong party was kept in the field until the end of June on the 6-inch survey; but for several cases of fever and dysentery towards the end of this work the health of the party was good, one draftsman died of consumption while on medical leave in May and one *khalasi* of fever at Kohát in June.

162. *Supplementary Topographical Survey on the 2-inch scale for preparation of 1-inch standard sheets.*—This work consisted, as in previous years, of testing by plane-table, a compilation of settlement *masavis* fitted together by means of traversed points. The area completed was 1,511 square miles in Multan and Muzaffargarh districts.

The Surveyor General in inspecting the previous season's work was of opinion that the survey of waste and desert areas had been pushed on too rapidly and with not sufficient regard to detail; efforts have been made to correct this fault during the field season, but have necessarily resulted in a slightly reduced output and increased cost; this work suffered from the fact that as the most experienced surveyors of the party were employed on the special surveys for the military authorities it had to be largely entrusted to beginners.

163. *District traverse.*—This was continued in Multán and Muzaffargarh districts, as in previous years. The outturn was small compared with that of previous years and with that proposed in the programme, this is due to the greatly reduced strength of the section employed on this work.

164. *Riverain traverse.*—This section was greatly strengthened with a view to nearly finishing the work during the season; it completed about 3,000 square miles of traverse work on the Indus, Jhelum, Chenab, Ravi and Sutlej rivers and in districts Jullundur, Ludhiána, Ferozepur, Montgomery, Siálkot, Amritsar, Lahore, Multán, Gujrát, Gujránwála, Jhang, Shahpur, Miánwáli, Dera Ismáil Khan and Bahawalpur State. Special efforts were made to give as much assistance as possible to officers actually engaged in settlement duty with, it is hoped, satisfactory results.

165. *Fair drawing.*—The drawing staff has been again increased during the year and although not yet strong enough to deal satisfactorily with the outturn of survey, it is as large as the staff of assistants can possibly supervise. A very large number of *masavis* has been dealt with in the riverain fair drawing, this work is now being pushed on as fast as possible, but will probably not be finished for about four years although the actual survey work will be completed during the coming field season.

The fair drawing of the current work in Multán and Montgomery has been carried out at Simla throughout the year and is now almost up to date.

The Himalayan section has also worked continuously at Simla and the arrears of this work should be finished within the next two years.

During the year, copies of the Simla survey sheets were coloured and this work is now finally disposed of. Some 4—7 draftsmen have been employed on special maps, such as the Aden Boundary and Aden general maps, and 6 special maps for the Foreign Office, throughout the recess season and on a smaller scale this work will continue throughout most of the coming field season.

166. The total expenditure of the party during the year has been Rs. 1,28,196, and of this Rs. 35,880 was expended on riverain surveys for the Punjab Government and Rs. 35,471 on special surveys for the military authorities. The cost rate for 2-inch supplementary survey, including compilation of maps, traversing and mapping, is approximately Rs. 16 per square mile.

167. *Programme for next field season.*—This allows for the supplementary survey on the 2-inch scale of some 4,000 square miles in Multán, Muzaffargarh, Dera Gházi Khán districts, and Bahawalpur State, district traverse in Bahawalpur State and Jhang and Lyallpur districts and the completion of all riverain surveys in the Punjab.

LIST OF FOREST DIVISIONS.

Province or State	Reference No. on Map	Division
N.W. Frontier	1	Hazara
Punjab	2	Ghaziabad
	3	Murree
	4	Kangra
	5	Kulu
	6	Jullundur
	7	Ambala
	8	Hoshiarpur
	9	Rohtak
	10	Gurgaon
	11	Hissar
Baluchistan	12	Baluchistan
United Provinces of Agra and Oudh	13	Dehra Dun
	14	Saharanpur
	15	Lansdowne
	16	Ramnagar
	17	Kumaon
	18	Almora
	19	Naini Tal
	20	Bareilly
	21	Pilibhit
	22	Gorakhpur
Bengal	23	Kurseong
	24	Darjeeling
	25	Buxa
	26	Jalpaiguri
	27	Cooch Behar
	28	Eastern Duars
	29	Western Duars
	30	Sonthalia
	31	Hill Tipperah
Assam	32	Goalpara
	33	Kamrup
	34	Nowgong
	35	Jhanjee
	36	Sibsagar
	37	Lakhimpur
	38	Cachar
	39	Khasi and Jaintia Hills
Burma	40	Upper Chindwin
Northern Circle	41	Myitkyina
	42	Lower Chindwin
	43	Shwebo
	44	Kyaukse
	45	Myingyan
	46	Kyauksa
	47	Minbu
Southern Circle	48	Thayetmyo
	49	Prome
	50	Tharrawaddy
	51	Bassein
	52	Thaton
	53	Southern Shwegyeen
	54	Northern Shwegyeen
	55	Salween
Pegu Circle	56	Toungoo
	57	Pegu
	58	Rangoon
Tenasserim	59	Tavoy
	60	Mergui
	61	Amherst
	62	Thatun
Bombay	63	Surat
Northern Circle	64	Dangs
	65	Nasik
	66	Thana
	67	Kolaba
	68	Ahmednagar
	69	Poona
	70	Satara
	71	Sholapur
	72	Belgaum
	73	Kanara
Southern Circle	74	Dharwar
	75	North Kanara
	76	South Kanara
	77	West Kanara
	78	Belgaum
	79	Kaladgi
	80	Bijapur
	81	Kolhapur
	82	Sawantvadi
Madras	83	Nilgiris
Northern Circle	84	Wynaad
	85	Nilambur
	86	Malabar
	87	Coimbatore
	88	Anamalais
	89	Palni
	90	Cumbum
	91	Madura
Southern Circle	92	Tinnevelly
	93	Ramnad
	94	Tanjore
	95	Trichinopoly
	96	Salem
	97	North Arcot
	98	South Arcot
	99	North Chingleput
	100	South Chingleput
	101	Nellore
Central Circle	102	Cuddapah
	103	Chingleput
	104	Kurnool
	105	North Coast
	106	South Coast
	107	Godavari
	108	Kistna
Hyderabad	109	Kistna
	110	Warangal
	111	Adilabad
	112	Nizamabad
	113	Aurangabad
	114	Parbhani
	115	Bhir
	116	Nander
Berar	117	North Melghat
	118	South Melghat
	119	Akola
	120	Amraoti
	121	Yeotmal
	122	Wun
Central Provinces	123	Nagpur Hyderabad
Northern Circle	124	North Chanda
	125	South Chanda
	126	Bhandara
	127	Balaghat
	128	Seoni
	129	Chhindwara
	130	Betul
	131	Hoshangabad
	132	Nimar
Southern Circle	133	Wardha
	134	Chanda
	135	Bastar
	136	Raipur
	137	Bilaspur
Rajputana	138	Abu
Central India	139	Gwalior
Bombay	140	Rewa Kantha
Baroda	141	Baroda
Mysore	142	Kadur
	143	Hassan
	144	Shimoga
	145	Mysore
	146	Coorg
Coorg	147	Coorg
Kashmir	148	Kashmir

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Reg. No. 2-S. 06

Reg. No. 968-S. 06.

FOREST SURVEYS.

No. 9 Party (Forests).

168. The Superintendent of Forest Surveys held charge of this party in addition to his other duties.

Personnel.

Major C. W. H. Symonds, I. A., Offg. Superintendent, to 3rd November 1904.
Major P. J. Gordon, I.A., Superintendent, Forest Surveys, from 4th November 1904.
Mr. James Marten, Extra Assistant Superintendent, 3rd grade, on leave to 4th May 1905.
Mr. A. Ewing, Extra Assistant Superintendent, 4th grade, to 27th October 1904.
Mr. J. Smith, Extra Assistant Superintendent, 4th grade, from 1st November 1904.
Mr. C. Litchfield, Extra Assistant Superintendent, 5th grade.
Mr. C. J. Veale, Extra Assistant Superintendent, 6th grade.
Mr. P. A. T. Kenny, Sub-Assistant Superintendent, 1st grade.
75 Surveyors.

169. The *locale* of operations, as formerly, lay in those parts of the Bengal Presidency where there was not sufficient forest survey work for a complete party. In Bengal a detachment under Mr. Smith completed the survey of the forests in the Angul district; in Burma two strong detachments under Messrs. Veale and Kenny carried out triangulation and traversing and 4-inch detail survey in the Katha, Shwebo, Ruby Mines and Mandalay districts; in Assam a detachment under Mr. Litchfield continued 4-inch detail survey in the Gáro Hills, Kámrup and Nowgong and carried out preliminary triangulation and traversing in Darrang and Sibságar; in the Punjab and North-West Frontier Province a small detachment under a native surveyor was employed throughout the year on 4-inch detail survey in Lahore, Jhelum and Hazára. In addition to these operations five surveyors were placed at the disposal of the Forest Department for the purpose of surveying the recently demarcated boundaries of mica mine leases in Kodarma and three surveyors were employed on triangulation and traversing in Berar.

170. The outturn and cost-rates for the year under report and the two previous years are given in the following table:—

Description of Survey.	Outturn in square miles.			Cost-rates per square mile.		
	1902-03.	1903-04.	1904-05.	1902-03.	1903-04.	1904-05.
Detail survey 4 inches = 1 mile.						
Bengal	232	310	232	64·0	64·0	78·8
Assam	134	160	148	97·8	85·2	87·9
Punjab and North-West Frontier	300	209(*a*)	262	35·3	25·0	25·3
United Provinces	100	36	...	29·7	27·1	...
Burma	303	447	501	63·5	90·7	94·0
Central Provinces	226	2·5	...	25·7	57·6	...
Total	1,295	1,164·5	1,143	...	...	...
Traversing	1,251 (*b*)	1,552 (*b*)	1,444 (*b*)	22·9(*c*)	23·9(*c*)	19·8(*c*)
Triangulation	990	2,483	2,242	10·4	7·7	6·4

(*a*) Outline survey. (*b*) Linear mile. (*c*) Per linear mile.

The cost-rates of triangulation and traversing are under the average, while those of detail survey are practically the same as for last year, except in the Punjab, where they are lower owing to the detachment employed there having worked throughout the year, and in Bengal where they are higher; this increase is partly due to the fact of the survey being in a new district, it being found that rates are generally higher in such cases; the distance of Angul from headquarters and the consequent expenses of transporting the detachment to and from the field helped to increase cost-rates in this district.

171. The average monthly outturn of a surveyor was 4 square miles with 187 fixings per mile.

172. Most of the field work has been mapped and will be sent to press before next recess. The triangulations and traverses have been completed and,

with the exception of the triangulation in Berar which was done by a native surveyor, the work has proved well.

173. Except in Assam, where there was a good deal of fever, health of the party was satisfactory.

174. The programme for 1905-1906 consists of—

(1) *North-West Frontier Province.*—Completion of Forest Surveys in Hazára.

(2) *Punjab.*—Boundary survey of the Rakhs of the Salt Range in Shahpur and some unimportant detail surveys in Ráwalpindi, Lahore, and Bashahr.

(3) *United Provinces of Agra and Oudh.*—Survey of leased Chir Forests in Tehri-Garhwál and of the Surai Banbasa forest in Oudh.

(4) *Eastern Bengal and Assam.*—4-inch detail survey of the Sitapahár reserve in Chittagong and of the remaining reserves selected for surveys in the Gáro Hills, Kámrup and Nowgong. The 2-inch detail survey of sheet No. 60 in Darrang.

(5) *Burma.*—Completion of 4-inch detail surveys in Shwebo and Katha districts east of the Mu river.

No advance triangulation or traversing for 4-inch surveys beyond what is required for current surveys will be done in view of the general reduction of the scale of Forest Surveys which has been proposed. In Berar two surveyors have been attached to No. 2 Party for the survey of the boundaries of the more important reserves on the 4-inch scale.

175. The party was inspected by the Surveyor General during October.

BOMBAY PRESIDENCY.

No. 17 Party.

Personnel.

Mr. B. G. Gilbert-Cooper, Superintendent, 2nd grade, in charge.
Mr. S. F. Norman, Extra Assistant Superintendent, 2nd grade.
Babu Amar Singh, Extra Assistant Superintendent, 6th grade.
Mr. P. R. Anderson, Extra Assistant Superintendent, 6th grade.
37 Surveyors, etc., and 1 writer.

176. Mr. B. G. Gilbert-Cooper held charge of the party throughout the year under report.

177. The party left Poona for the field at the end of November 1904, and returned to recess quarters at the end of May 1905, giving a full working season of six months.

The party, divided into three camps under Messrs. S. F. Norman, Amar Singh and P. R. Anderson, continued the survey on the 4 and 8-inch scales of forest areas in the Northern and Central circles of the Bombay Presidency.

The operations comprised:—

(1) *Northern Circle.*—Continuation of the detail survey of teak reserves in the Thana District on the 8-inch scale.

(2) *Central Circle.*—Continuation of the supplementary triangulation and detail survey on the 4-inch scale of forests in the Sátára District. Detail surveys on 4 and 8-inch scale in the Násik District.

Continuation of the supplementary triangulation, and detail survey on the 4-inch scale in the Khándesh District.

In addition to the above 22¼ miles of the boundary between the Khándesh District and the Barwáni State, Central India Agency, were traversed by theodolite at the request of the Bombay Government. The triangulation and traversing were done entirely by native agency.

On the recommendation of the Forest Department the Government of Bombay approved of the scale of survey in the Peint Táluka of Nasik being reduced from 8-inches to 4-inches to the mile and also sanctioned the abandonment of the survey of proposed forests in Sátára.

178. The health of the party was on the whole good; one surveyor died of sunstroke in the field and 1 sub-surveyor and one probationary sub-surveyor died of plague during the recess season in Poona; the death of the two former, both highly trained surveyors, being a serious loss to the party.

179. The following table shows in detail the outturn and cost-rates for the year under report and the two previous years :—

Description of Survey.	Outturn.			Cost-rates.		
	1902-03.	1903-04.	1904-05.	1902-03.	1903-04.	1904-05.
Triangulation (square miles)	1,373	677	1,010	1·11	15·3	12·2
Traversing (Linear miles)	...	...	22·5	...	...	13·7
Topography, 4-inch scale (square miles).	486·73	576·19	597·48	61·0	67·5	62·3
Topography, 8-inch scale (square miles).	239·97	157·75	187·47	130·0	138·8	144·8

The cost-rate of triangulation is less than that of last season and that of 4-inch detail survey is also less than that of similar work for the past two years. The cost-rate of 8-inch detail survey is, however, somewhat higher than last year's rate. This increase is principally due to the party having to bear for the first time in its history a charge of 4 per cent. on its total expenditure on account of instruments supplied. The decrease in the cost-rate of 4-inch surveys is mainly due to the area surveyed on that scale being greater than formerly. On the whole the cost-rates may be considered satisfactory.

180. The detail survey was tested by one linear mile of test line to 1·7 square miles surveyed.

181. The averages were very consistent. A surveyor working 24 days in the month was found to be able to survey 2·23 square miles per month on the 8-inch scale with 228 fixings per mile and on the 4-inch scale 4·46 square miles with 117 fixings.

182. During the recess the mapping has made good progress, 156 sections having been sent to press during the year.

Every effort has been made to deal with the arrears of mapping, and it is hoped that before the close of the current recess season every section pertaining to the year 1903-04, as well as some of those of the year under report, will be submitted for publication.

183. In the course of the work the Tánsa lake from which the main water supply of Bombay is obtained was surveyed and the resulting maps will doubtless prove of great value to the Municipality of that city as well as to the Forest Department.

184. Due attention was paid to the training of young surveyors, seven probationers having been placed under a senior surveyor working in easy country for instruction. Towards the end of the season most of the probationers were able to survey independently and the experiment has proved a decided success.

185. The programme for 1905-1906 is in continuation of that for the past season. The 8-inch surveys in Thána will be completed, thus bringing the programme of the party in the Northern Circle to a conclusion.

Triangulation will be completed in Khándesh and it is hoped that it will also be found possible to complete the triangulation of a small area of about 50 square miles in the Sinnar Táluka of Násik.

The detail survey on the 4-inch scale of the reserved forests in the Western Tálukas of Sátára will be completed and the survey of the Khándesh forests on the same scale will be continued.

186. The party was inspected in September by the Superintendent of Forest Surveys.

MADRAS PRESIDENCY.

No. 19 Party.

187. Major Robertson held charge until the 20th August 1905 when, on his transfer, Mr. Hall was appointed to the charge of the party.

Personnel.

Major C. L. Robertson, C. M. G., R. E., Deputy Superintendent, in charge up to the 19th August 1905.
Mr. G. T. Hall, Extra Assistant Superintendent, 1st grade, in charge from 20th August 1905.
Mr. W. F. E. Adams, Extra Assistant Superintendent, 5th grade.
Mr. M. J. Sheehan, Extra Assistant Superintendent, 6th grade.
Mr. C. C. Byrne, Sub-Assistant " 1st grade.
Mr. B. G. Newland, " " 2nd grade.
53 Surveyors and two writers.

The party divided into three camps under Messrs. Hall, Adams and Sheehan was employed on—

(1) Four-inch detail survey of forest reserves in Gódávari.
(2) Triangulation and 4-inch detail survey of forest reserves in South Canara.
(3) Triangulation and 4-inch detail survey of forest reserves in Ganjam.
(4) Triangulation in North Malabar. In addition to the above camps, Surveyor Balaji Dhondiba with six sub-surveyors was employed on revision surveys in North Coimbatore and a sub-surveyor was deputed to assist in the demarcation of the Mysore South Canara Boundary.

188. The party left Bangalore early in November 1904 and continued field work until May 1905 when it returned to recess quarters. An area of 1,022 miles was triangulated in South Canara, Malabar and Ganjam, but only about one-third of this area was under the Forest Department. Owing partly to the forest blocks being much scattered and also to the absence of secondary series in the Presidency, the area triangulated is necessarily much larger than is actually required for 4-inch topographical purposes.

189. Only 29 linear miles of boundary were traversed by theodolite. This small outturn was partly due to boundary lines not being cleared in advance. It is considered desirable to prevent encroachments that a theodolite traverse should be carried out of all exterior forest boundaries in Madras and where this has been omitted in the past it will be done during the general topographical survey of the country.

190. Seven hundred and fifty square miles inclusive of 134 square miles of revisionary survey in Coimbatore were topographically surveyed on the 4-inch scale. The area was less than for last year. This was partly due to several surveyors having been employed on a test survey on the 1-inch scale for the Indian Survey Committee and partly to the difficult nature of the country.

191. The work was thoroughly tested in the field and proved accurate.

192. The average outturn per man per month varied from 5·5 square miles in Coimbatore to 2·2 in Ganjam.

193. The country presented much the same difficulties as formerly. In the forests of Godavari and Ganjam with their almost impenetrable undergrowth and bad water, difficulty of securing supplies and general unhealthiness were experienced, while in South Canara with its dense ever green forests there were few villages and much time and labour were expended in clearing lines.

194. On the whole the health of the party was better than it was last season but the menials suffered considerably from fever and dysentery. A Hospital Assistant was attached for three months to the Gôdávari section and this helped to maintain its efficiency.

195. Most of the computations have been brought up to date during the recess.

196. Inclusive of 49 sheets partially mapped last year the fair mapping comprised 93 sheets; of these, 14 sheets of the Gódávari District are withheld from publication for verification of boundaries. In South Canara 8 sheets cannot be submitted without further references to the District Forest Officer. In Kurnool 13 sheets being arrears of previous years and five sheets of the Guntur Kistna District will be submitted for publication in October. Of the North Coimbatore revision work 13 sheets will be submitted.

197. The actual expenditure for the survey year ending 30th September 1905 inclusive of cost of instruments is R1,07,642 as compared with R1,07,701 in the previous year.

The following table shows the cost-rates of the different classes of survey and the areas surveyed during the year under report and two preceding years :—

Description of Survey.	Area surveyed.			Cost-rate per square mile.		
	1902-03.	1903-04.	1904-05.	1902-03.	1903-04.	1904-05.
Triangulation .	2,030	1,937	1,022	5	9	14·0
Traversing . .	538	247	29	13	19	30·6
Topography (*a*) .	1,411	803	750	58	102	123·3

(a) Includes 134 square miles of revision survey in North Coimbatore District and excludes 135 square miles test survey on the scale of 1-inch = 1 mile.

The increase in cost rates is partly due to increase of pay of establishment, additional local labour at enhanced rates in certain localities, and to the unhealthiness of the Gódávari and Ganjám Districts. These circumstances do not, however, in themselves satisfactorily account for the increased cost-rates : the increase is principally due to the fact that a large number of the surveyors who had suffered severely from fever during the previous season took the field in a debilitated state and were unable to produce the outturn they otherwise would have done. The party has now been employed for many years on the survey of forest tracts and the majority of the surveyors are now working in the remote and notoriously unhealthy districts of Ganjám and Gódávari which are especially distasteful to the class from which the Surveyors of the Party are recruited. The scattered nature of the work and the difficulties of communication render supervision difficult and the men become disheartened with the poor results obtained after days of monotonous toil in the dense jungles where often even the aborigines refuse to work. Everything that can possibly be done will be done next season to improve results and the prospect of a change of programme will do much to encourage the men.

198. The programme for the ensuing season comprises Malabar and the Nílgiris with a view to the 2-inch topographical survey of sheets 35, 53, 54 and 55 ; the continuation of the theodolite traversing of the Mysore South Canara boundary and of the boundaries of forest reserves in North Malabar, and the 4-inch detail survey of forests in Gódávari, Ganjám, South Canara, North Malabar and Chingleput. One surveyor will also be deputed to accompany the Joint Commissioners who are demarcating the boundary between South Canara and Mysore.

199. During August the party was inspected by Major P. J. Gordon, I.A., Superintendent, Forest Surveys.

200. Forest right and boundaries, with the exception of those in Gódávari, were verified during recess by the District Forest Officers.

BURMA.

No. 20 Party.

Personnel.

Captain A. Mears, I.A., Officiating Deputy Superintendent, 2nd grade, in charge.
Mr. P. F. Prunty, Extra Assistant Superintendent, 2nd grade.
Mr. M. C. Petters, Extra Assistant Superintendent, 6th grade.
Mr. S. S. Mc. Fielding, Sub-Assistant Superintendent, 1st grade.
Mr. J. H. Williams, Sub-Assistant Superintendent, 1st grade.
Munshi Amjad Ali, Sub-Assistant Superintendent, 2nd grade.
67 Surveyors, etc., and two writers.

201. Captain A. Mears, I. A., held charge of the party throughout the year under report, except from the 9th June to the 22nd July 1905 when, during his absence on privilege leave, Mr. P. F. Prunty officiated.

The party left recess quarters at Dehra on the 12th November and commenced field work early in December, the field season lasting until the middle of May.

202. The party, divided into five camps and two small sections, was employed on—

(1) Triangulation and traversing in the Yaw forest division (Pakôkku district).
(2) Traversing for revision survey in the Thaungyin district.
(3) 4-inch detail survey of Forest Reserves in the Lower Chindwin, Myittha and Yaw forest divisions (Upper and Lower Chindwin and Pakôkku districts) and in the Thayetmyo district.

203. Subsidiary triangulation based on the Manipur Minor Meridional Series was continued by Mr. Prunty southwards from the previous season's work over an area of about 800 square miles in the Pakôkku district.

204. Owing to the denseness of the forest growth the triangulation had to be supplemented by a network of theodolite traverses for the purpose of furnishing the plane tablers with additional points and heights.

Nine hundred and seventy-six linear miles were traversed in an area of about 1,000 square miles. The theodolite was set up on an average 18 times in every linear mile. With few exceptions all the traverses were set up and proved in the field.

205. An area of 680 square miles comprising reserves in the Upper and Lower Chindwin, Yaw and Thayetmyo forest divisions was topographically surveyed on the 4-inch scale.

The detail survey, owing to the intricate nature of the thickly wooded country, was as usual carried out by plane-table traversing always a slow and laborious process.

The absence of villages in or near the reserves necessitated the establishment of numerous food depôts for supplying the surveyors and followers with provisions, and, owing to the elephant establishment being under strength and local labour scarce, considerable difficulties and anxiety were experienced, especially at the commencement of the season, in stocking these depôts.

206. The area under topographical survey was carefully examined in the field by one linear mile of test line to every 1·77 square miles of 4-inch detail survey.

The work, rigorously tested in this manner by the officer in charge and his assistants, proved satisfactory.

207. The average outturn of 4-inch detail survey was 3.36 square miles per man per month. The plane table was set up on an average 171 times in every square mile surveyed.

208. The health of the party was generally good. There were seven deaths among the *khalasis*, of which five were due to cholera on the journey to the field.

209. During the recess months the triangulation and traverse computations were completed. The fair mapping of the past season's work will be finished, with the exception of two incomplete sheets, before the party takes the field; 36 sheets have been submitted for publication during the year under report. There are no arrears of mapping in the party.

210. The total expenditure incurred on survey operations for the year ending 30th September 1905 amounts to R1,51,677 as compared with R1,39,510 for the previous year. The increase is chiefly due to the purchase of 2 new elephants at a cost of over R6,000.

211. The following table shows the outturn and cost-rates for the year under report and the two previous seasons:—

Description of Work.	Area surveyed.			Cost-rate in rupees per square mile.		
	1902-03.	1903-04.	1904-05.	1902-03.	1903-04.	1904-05.
Triangulation	1,161	610	800	3·2	7·4	7·7
Traverse	1,173 (*a*)	948 (*a*)	976 (*a*)	44·7 (*b*)	44·5 (*b*)	43·9 (*b*)
Topography 4"	623	671	680	136·6	135·7	140·8

(*a*) Linear miles of traverse survey.
(*b*) Cost-rate per linear mile.

The cost-rates of triangulation and traversing are practically the same as for the previous season and may be considered fair average rates for thickly wooded and undulating country in Burma.

The cost-rate per square mile for 4-inch detail survey has risen by R7 per square mile. This increase is regrettable and is due to the failure to reach the anticipated outturn of detail survey by 40 square miles, owing to two of the detail camps being much delayed in reaching their ground through difficulties experienced in obtaining sufficient local carriage. This difficulty would not have arisen had two newly purchased Kheddah elephants arrived as arranged for, at the commencement of the season. This shows how small circumstances may seriously affect a season's outturn. When these elephants eventually reached the party they were unfit for work and both died within two months of their arrival.

The charge of 4 per cent. on the total expenditure of the party on account of instruments supplied was taken into account, for the first time since the party was attached to the Forest Survey Branch, in calculating the cost-rates, and this fact must also be taken into consideration in making a comparison with the cost-rates of previous years.

212. The programme for 1905-1906 is as follows:—

(1) Triangulation and traverse survey to complete standard sheets 66, 67, 68, 69 and 70 with a view to these sheets being surveyed topographically on the 2-inch scale.

(2) Topographical survey on the 4-inch scale in the Lower Chindwin, Yaw, Thayetmyo and Thaungyin forest divisions.

213. The Superintendent, Forest Surveys, inspected the party in the field in January and in recess in October 1905.

CADASTRAL AND TRAVERSE SURVEYS.

BENGAL.

214. The operations in Bengal remained under the supervision of Major R. T. Crichton, I.A., Superintendent, Provincial Surveys. During the year under report the 6 detachments have been formed into two parties and the surveys in Bengal are now carried out by three large field parties. The outturn of the season, which is again the largest accomplished as yet, is as follows:—

	Square miles.
Traversing	6,326
Cadastral survey	4,481
Record-writing	4,512
Topographical survey on 4-inch and smaller scales	572

NO. 4 PARTY.

Personnel.

Lieutenant L. C. Thuillier, Officiating Assistant Superintendent, 1st grade, in charge.

Traverse.

Mr. P. L. Causley, Extra Assistant Superintendent, 6th grade.

Mr. C. A. O'Donel, Extra Assistant Superintendent, 6th grade.

Mr. H. A. Hardless, Sub-Assistant Superintendent, 2nd grade.

1 Supervisor, 45 Traversers and 34 Computers.

Cadastral.

Mr. C. S. Kraal, Extra Assistant Superintendent, 3rd grade.

Mr. W. Skilling, Extra Assistant Superintendent, 4th grade.

Mr. J. C. Lears, Sub-Assistant Superintendent, 1st grade.

Mr. O. J. H. Hart, Sub-Assistant Superintendent, 1st grade.

Mr. G. W. Archer, Sub-Assistant Superintendent, 2nd grade.

Mr. T. F. Kitchen, Sub-Assistant Superintendent, 3rd grade.

4 Supervisors, 73 Inspectors, 854 *amins*, 1,262 *moharrirs*, chainmen, etc.

215. This party consisted of one traverse and two cadastral camps and was employed in the Bhágalpur and Purnea districts.

BENGAL.

INDEX TO TRAVERSE SURVEYS.

1904-05. Nos. 4, 5, & 6 PARTIES.

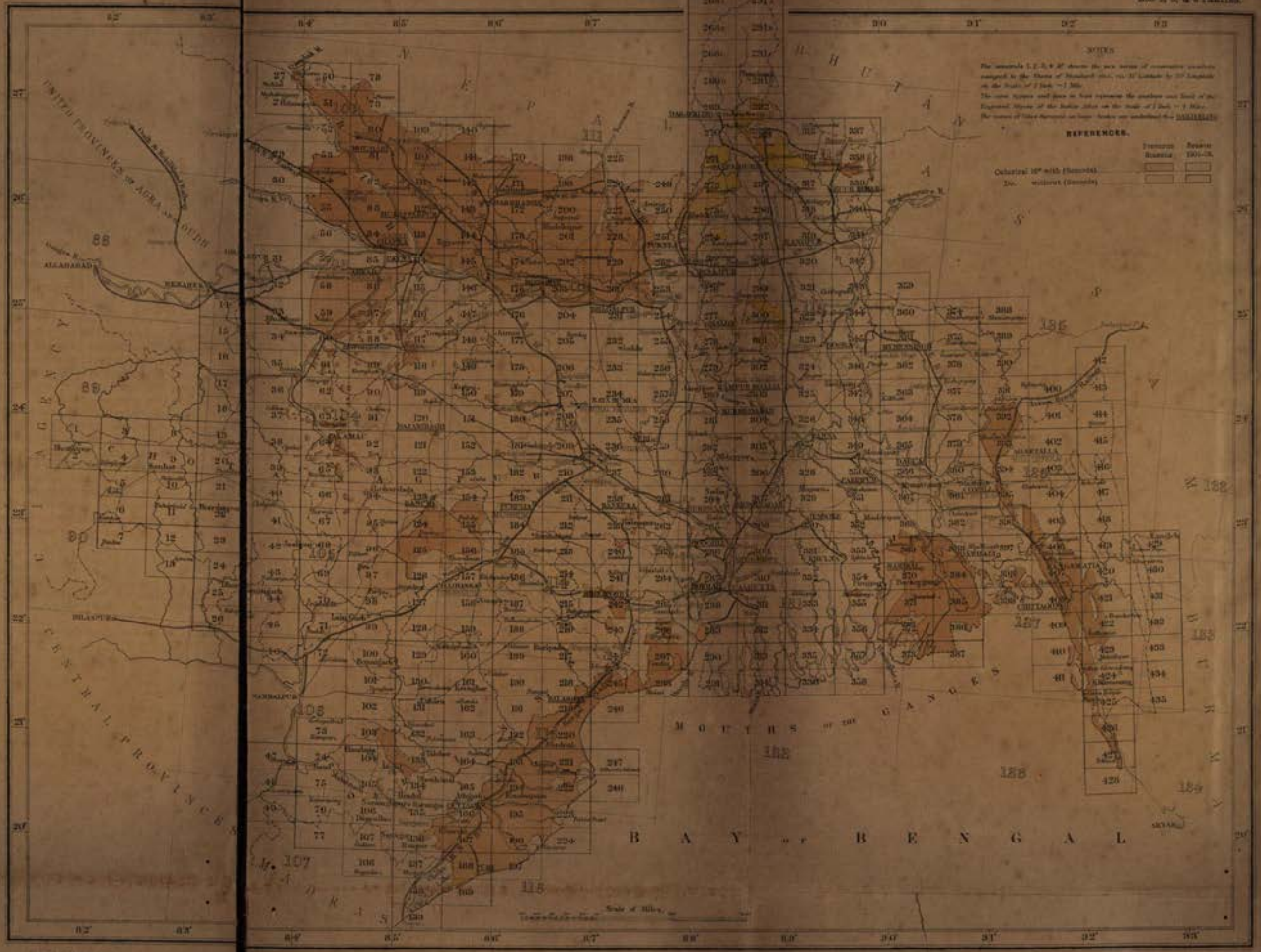
Published under the direction of Colonel C. Strahan, R.E., Surveyor General of India.
August 1905.
Reg. No. 1044-S. 06.

BENGAL.

INDEX TO CADASTRAL SURVEYS.

1904-05.

Nos. 4, 5, & 6 PARTIES.



Published under the direction of Colonel C. Strahan, R.E., Surveyor General of India.

August, 1905.

Reg. No. 1045-S. 08.

The outturn for the season is as follows:—

District.	Nature of operations.	Area in square miles.	Cost-rate per square mile.
			R
Bhágalpur	Traversing for cadastral survey	1,250	31·7
	Traversing for topographical survey	130	6·5
	Cadastral survey	24	85·4
	Record-writing	24	28·5
	Topographical survey, 4 inches = 1 mile.	123	17·9
Purnea	Traversing for cadastral survey	468	47·8
	Traversing for topographical survey	234	4·5
	Cadastral survey	1,748	73·5
	Record-writing	1,748	35·6
	Topographical survey, 4 inches = 1 mile.	129	17·6

The cost-rate for traversing in Bhágalpur is very fair, the higher rate in Purnea being due to a smaller and detached programme. The rates for cadastral survey and record-writing in both districts are very good, especially considering the unhealthiness of the locality. The topographical surveys were confined to the Kosi river "*diara*" tract which has now been completed. The procedure adopted in this tract was described in paragraph 163 of last year's report.

216. The traversing has been suitably connected with the Great Trigonometrical survey and proves well. There were 40,241 theodolite stations which were marked by 5,395 stones at trijunctions and 30,344 cylinders and 4,502 pegs at other points. The pegs were principally used in the "*diara*" tracts where any attempt at preservation of marks is useless. Demarcation in the uplands was fairly good, and was not required in the "*diara*" except in the Government estates where it was conspicuous by its absence and caused a good deal of extra work at the traverse stage. The detail survey was checked by nearly 5 linear miles of test survey for each square mile of detail and over 27 per cent. of the record-writing has been checked by the Survey staff.

No. 5 Party.

Personnel.

Captain F. C. Hirst, I.A., Officiating Assistant Superintendent, 1st grade, in charge.

Traverse.

Mr. T. W. Babonau, Extra Assistant Superintendent, 4th grade.
Mr. L. B. Fitzgibbon, Sub-Assistant Superintendent, 2nd grade.
1 Supervisor, 40 traversers and 22 computers.

Cadastral.

Mr. H. W. Biggie, Extra Assistant Superintendent, 5th grade.
Mr. C. S. Gasper, Extra Assistant Superintendent, 5th grade.
Mr. P. F. Delaney, Sub-Assistant Superintendent, 2nd grade.
Mr. A. B. Smart (Junior), Sub-Assistant Superintendent, 3rd grade.
4 Supervisors, 82 inspectors and 920 *amins*.

217. This party also comprised one traverse and two cadastral camps and has accomplished the following outturn in Ranchi, Midnapore and Singhbhum districts.

District.	Nature of operations.	Area in square miles.	Cost-rate per square mile.
			R
Ranchi	Traversing	1,632	29·5
	Cadastral survey	909	51·5
	Record-writing	1,040	30·6
Midnapore	Cadastral survey	27	207·3
	Record-writing	149	104·1
Singhbhum	Cadastral survey	594	47·2
	Record-writing	594	32·6

The cost-rate for traversing is low, owing to large villages and large tracts of waste land, but is particularly satisfactory, as owing to the hilly nature of three-fourths of the area the subtense-bar had to be constantly used. The low rates for cadastral survey with records in Ranchi and Singhbhum are noticeable and are due principally to large fields and labour being readily supplied free. The average size of the field in Ranchi was 1·3 acres and in Singhbhum 1·1 acres. The Midnapore rates are exceptional as the work was entirely confined to completion of scattered arrears of previous season. This sort of work must prove costly.

218. The traversing has been connected with the Great Trigonometrical survey and proves well. In Ranchi there were 30,350 theodolite stations; trijunctions being marked by stones with dots cut in the centre and all other points either by stones with a "broad arrow" cut thereon or else the broad arrow was cut on the rocks "*in situ*." There are no Revenue survey or other old maps of Ranchi showing village boundaries, and as the demarcation was found wanting, the surveyors, with the help of the Deputy Commissioner's list of villages, surveyed the boundaries as pointed out.

219. In both Ranchi and Singhbhum the detail survey has been checked by nearly 3½ linear miles of test survey to each square mile of detail and from 15 to 21 per cent. of the record-writing has been checked by the survey staff. The local establishments although now in their third year of employment only averaged 16 acres of cadastral survey and 23 numbers of record-writing a day. These outturns are very poor and would have seriously affected the cost-rates if labour had not been supplied free. The health of the establishments in all these districts was very indifferent, principally owing to malarial fever.

No. 6 Party.

Personnel.

Mr. A. W. Smart, Extra Deputy Superintendent in charge.
Mr. N. Bedford, Extra Assistant Superintendent, 4th grade.
Mr. C. H. G. Johnson, Extra Assistant Superintendent, 5th grade.
Mr. E. G. Hardinge, Extra Assistant Superintendent, 6th grade.
Mr. O. E. C. Judd, Sub-Assistant Superintendent, 2nd grade.
Mr. P. Kennegy, Sub-Assistant Superintendent, 2nd grade.
Mr. F. W. Marten, Sub-Assistant Superintendent, 2nd grade.
Mr. I. Newton, Sub-Assistant Superintendent, 3rd grade.
4 Supervisors, 62 traversers, 32 computers, 49 inspectors and 926 *amins*.

220. This party comprised one traverse and one cadastral camp and one camp employed on both traversing and topographical survey.

The areas accomplished are as follows :—

District:	Nature of operations.	Area in square miles.	Cost rate per square mile.
			R
Faridpur	Traversing	1,893	45·4
Backergunge . . .	Traversing	27	43·4
	Cadastral survey . . .	1,168	108·7
	Record-writing . . .	950	36·7
Backergunge Sunderbans .	Traversing . . .	571	37·0
	Topographical survey . . .	320	33·5

The rate for traversing in Faridpur is very fair considering that the southern half of the tract consists principally of large swamps intersected by streams and the northern half of thickly wooded uplands where heavy line-clearing was necessary. The rates for cadastral survey and record-writing for Backergunge are slightly higher than last season owing to much smaller fields. The average size of the field was 0·87 of an acre. The rates for the work in the Sunderbans are good considering the very difficult nature of the work.

221. In the traversing in Faridpur and Backergunge (excluding the Sunderbans) there were 45,167 theodolite stations which have been marked by 6,361 stones, 880 galvanized iron cylinders and 37,926 pegs. The cadastral survey has been checked by an average of over 4 linear miles of test survey to each square mile of detail and in the record-writing the entries against 22 per cent. of the plots have been checked. In the Sunderbans the area of 571 square miles comprises 251 square miles of more or less cleared lands which have been surveyed cadastrally and 320 square miles of dense forest and jungle cut up by innumerable streams and tidal creeks of which only a topographical survey was done. The usual procedure for marking of traverse stations had to be abandoned in the Sunderbans as owing to the spongy, water-logged nature of the soil, stones would have disappeared in a short time. The trijunction points have therefore been marked by 145 galvanized iron cylinders and 20 trunks of trees sawn off a little above ground level. Other salient points have been marked by 11 iron cylinders and 397 trunks of trees. At all the remaining 5,671 theodolite stations, wooden pegs 3 feet long and 4 inches in diameter have been driven into the ground. In addition to these marks, at all stations in the forest and jungle areas, cross sticks painted white were affixed to, or a white cross was painted on, an adjoining tree. Without these marks the identification of stations at the topographical stage would have been almost impossible. The density of the forest and jungle precluded any attempt at systematic line-clearing consequently a system of zigzag traversing was adopted of which successive stations were located on opposite banks of the creeks and streams and the distances measured by means of subtense-bars. This necessitated only small V shaped clearings at each station and has been a complete success as the traversing has proved very well.

222. There have been great difficulties to contend with in this survey. The establishment had to live in boats and as absolutely nothing was obtainable locally, all drinking water and supplies had to be sent out to them at regular intervals. Towards the end of the season the high winds and sudden storms which occur near the Bay of Bengal made boat work very dangerous. Notwithstanding all the precautions taken, the want of fresh water caused a great deal of sickness, specially skin diseases and sores from which fully 75 per cent. of the men suffered severely. Malarial fever and dysentery were prevalent also and lastly there was considerable danger to life owing to the country being infested with tigers. Two *khalasis* were killed by tigers and there were several narrow escapes. As a consequence the establishments absconded wholesale and very great difficulty was experienced in replacing them.

MISCELLANEOUS SURVEYS.

223. *Calcutta Municipality.*—The detachment under Mr. R. B. Smart, Extra Deputy Superintendent (retired) continued the operations in the added area of Calcutta and the adjoining Panchánnagrám Estate. The outturn of the year is as follows:—(*a*) Traverse of 2,090 acres. of Dihi Panchánnagrám lying outside the municipal boundary, (*b*) detail survey of the foregoing area on the scale of 32 inches to the mile and (*c*) detail survey of 1,430 acres on the scale of 50 feet to the inch. The field work of this detachment is now practically finished but a lot of work still remains in the way of demarcation and reconciliation of municipal and revenue holdings and the area extraction which is difficult can only proceed as demarcation advances. Out of 393 fair sheets 133 have been completed in skeleton, *i.e.*, all details have been drawn with the exception of the boundaries of holdings which can only be entered as attestation progresses.

224 *Patna Division diara survey.*—With a view to the annual checking of accretion and diluvion in "diara" tracts the Board of Revenue ordered that the present position of the Ganges river be marked on maps of the latest surveys. This work was taken up by No. 4 Party, the procedure adopted being to run traverses along each bank of the river as close to the water's edge as feasible connecting them with trijunctions of the former survey and then to map the actual water's edge by offsets. A set of maps on the 16-inch scale was compiled showing the course of the river as previously surveyed in black and on these maps the present position of the river has been shown in red. The total length of the survey is 354 miles and the approximate area enclosed 55 square miles. Next season permanent marks will be embedded at selected points near the river and on high lying islands, and if a fair number of these marks are found remaining after the rainy season it should be possible to re-map the river as required without necessity for an expensive theodolite survey on each occasion.

225. *Relaying Jalpaiguri-Cooch Behar boundary.*—This work has been held over for several seasons as no officer was available to take it up. This season Mr. O'Donel was deputed for the purpose and it has now been done and a report with maps and data is being sent to the Deputy Commissioner of Jalpaiguri.

226. *Minor operations.*—The following minor operations have also been carried out during the season:—(*a*) relaying the Revenue Survey boundary of an estate in the Malda district which entailed the skeleton traversing of 53 square miles, (*b*) traversing for cadastral survey 2 villages, covering 6 square miles in Patna, (*c*) cadastral survey of one village in Ranchi and (*d*) demarcation of the Udaipur State boundary.

BENGAL DRAWING OFFICE.

227. During the year under report the Bengal Drawing Office has been moved from Free School Street to more commodious and suitable quarters at 166, Lower Circular Road. In addition to its original work of compilation of standard sheets this office has gradually undertaken a very heavy and varied programme and is now divided into 5 main sections.

(*a*) *Standard maps.*—During the year four 1-inch standard sheets, Nos. 143, 170, 199 and 200, comprising portions of Darbhanga, Monghyr and Bhágalpur districts, have been completed and submitted to the Surveyor General's Office for publication. Seven sheets, Nos. 145, 146, 171, 172, 173, 174 and 175, are in hand, of which 3, Nos. 145, 146 and 171, are practically complete and will be submitted shortly.

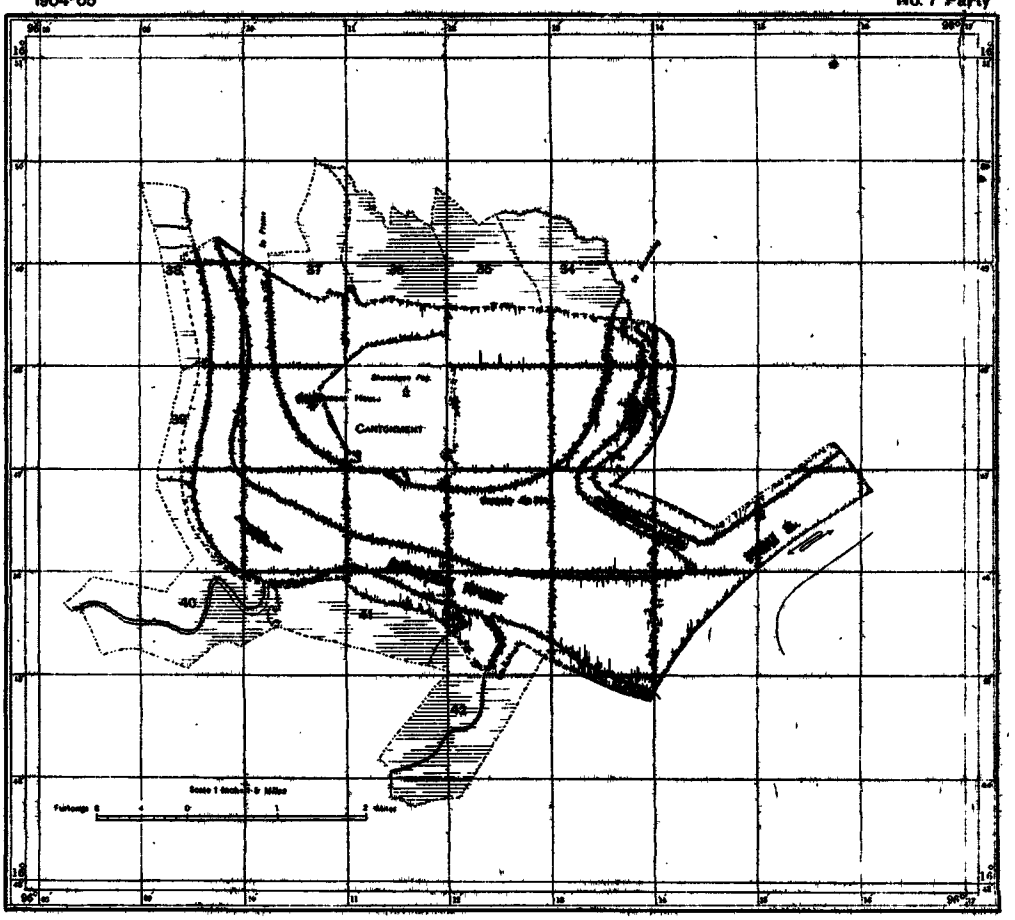
(*b*) *District maps.*—During the year the district maps of Saran and Cuttack have been completed and submitted for publication. That of Puri has also been completed and will shortly be submitted. The map of Champaran is well advanced and that of Darbhanga is as far advanced as the state of the standard sheets permits. It has been decided that a map of Chittagong should be compiled and it is in hand but the incorporation of old material for the gaps left in the latest survey, which is necessary to complete the map, is proving troublesome.

(*c*) *Traverse charts.*—The necessary computations for the compilation of these charts are now well advanced and it is hoped that 27 charts will be ready by 1st April 1906 and another 79 by October 1906.

BURMA

Index to the Survey of the Town of Rangoon

1904-05 No. 7 Party



No 331. S. I —Sept 05 —75.

Photo. S. I. O., Calcutta.

Origin of Survey { Lat. N. 16-46-13·22 / Long. E. 96-12-05·05

REFERENCES

Surveyed during Season 1895-97 .....

Surveyed during Season 1904-05 .....

Municipal Boundary .....

Block .....

Block Number 42

Reg. No. 1080-S. 05.

(*d*) *Thana maps.*—These maps showing the serial numbering of villages and certain other details are compiled for the local Government and during the year the maps of 14 *thanas* have been published. Trijunction mark maps (required by the Settlement Department) of Gya and Shahabad have been completed and those of Patna and the Orissa districts are well advanced.

(*e*) *Reproduction of village maps.*—During the year 17,547 sheets have been traced, 12,354 have been examined, 280,822 copies have been printed and 239,082 despatched to Collectors and Settlement Officers. The programme for the next season is double that of the outturn just accomplished and everything points to a still larger and early increase, as copies of village maps are to be supplied to every "*paroha*" holder who is in possession of a plot. This frequently means the supply of 2,000 or more copies of a village map. In connection with this section a small "*badar*" establishment varying from 3 to 8 draftsmen has been maintained so as to deal with "*badars*" in the original sheets which become apparent when examining the traces.

(*f*) *Badar section.*—This section consisting of about 12 cadastral draftsmen and area estimators deals with "*badars*" received from the several Settlement officers and corrects the spelling of village names on original sheets and traverse tables in accordance with the *thana* lists supplied by the Settlement department.

(*g*) *Map record section.*—During the year 3,081 original sheets have been received for record from the field parties and 1,357 from the Surveyor General's office. The total number of original maps now lodged in the office is 81,592. The removal and re-erection of the large racks and of all these sheets to the new office has been a task of considerable difficulty but the opportunity has been taken to re-arrange all the maps by *thanas*. The paper traces which are prepared prior to reproduction by the Vandyke process are also kept in this section and a register is under preparation so that they will be readily traceable should further demands for copies arise.

228. Major Crichton inspected all the parties and camps several times during the field season and Nos. 4 and 6 Parties with all their camps during recess. He inspected the Bengal Drawing office constantly during the year and also the office of the Calcutta Suburbs survey.

UPPER AND LOWER BURMA.

No. 7 Party.

Personnel.

Lieut.-Colonel G. B. Hodgson, I.A., Superintendent, 1st grade, in charge until 2nd November 1904 and also from the 12th May to 5th July 1905.

Major C. W. H. Symonds, I.A., Deputy Superintendent, 1st grade, in charge from 26th November 1904 to 12th May 1905, and again from 12th August 1905.

Mr. J. S. Swiney, Extra Assistant Superintendent, 2nd grade.

Mr. O. D. Smart, Extra Assistant Superintendent, 4th grade, in charge from 3rd to 25th November 1904 and from 6th July to 11th August 1905.

Mr. C. Graham Lee, Extra Assistant Superintendent, 5th grade.

Babu Jagdamba Prasad, Extra Assistant Superintendent, 6th grade.

Babu A. C. Bose, Sub-Assistant Superintendent, 1st grade.

Mr. W. E. S. Swiney, Sub-Assistant Superintendent, 3rd grade.

17 Traversers, 14 computers, 17 draftsmen, 4 typers, 5 estimators, 9 inspectors and 89 field surveyors.

229. The cadastral survey of the Pakôkku district was continued and a large scale survey was carried out of an area of 9·3 square miles recently added to the Rangoon municipality. The programme was completed and the outturn of the season was as follows :—

Local.	Traversing.			Detail Survey.						
	Kwins.	Square miles.	Cost per square mile including demarcation.	*Kwins.*	Sheets.	Fields.	Acres.	Square miles.	Cost per square mile.	Size of field.
			R			(*b*)	(*b*)	(*a*)	*R*	(*a*)
Pakôkku cadastral	355	694	58	462	766	190,946	412,800	605	114	1·5
Pakôkku topographical	34	53	...	24	53	...	...	39·8		
Rangoon Town	...	9·3	2,064	...	107	22,071	5,952	9·3	3,887	0·26
Total										

(*a*) Calculated on the cultivated area only.
(*b*) Includes jungle.

230. *Pakôkku District.*—Field work commenced on the 10th November 1904 and closed on the 2nd May 1905. The traversing was done under the supervision of Mr. J. S. Swiney. The Seikpyu township was completed and a small area in Pauk as well as 34 *kwins* of Pakôkku situated in the bed of the Irrawaddy. The country traversed was mostly undulating and covered with thin scrub jungle. Absence of water was severely felt in parts as owing to it the surveyors had at times to encamp at long distances from their work. The average number of traversers was 12 for 5½ months and their average daily outturn amounted to 8 angles and 134 chains. The traversing was connected to 2 G. T. S. stations of the Manipur meridional series and 4 stations of minor triangulation of No. 10 Party which was also carried out during the season under report. Double chaining was employed throughout and amounted to a total of 1,705 linear miles. The theodolite was set up at 12,555 stations, of which 10,901 were new and were marked with the usual galvanised iron cylinders at an approximate cost of 9·3 annas per station. Observations for azimuth were made at 84 stations and vertical angles were observed at 3,101 stations and their heights computed. The origin of survey was the same as that of previous seasons.

231. The cadastral survey was carried out under the supervision of Mr. Lee assisted by Babu Bose and Mr. W. E. S. Swiney. The average number of *amins* employed was 64 for 150 days with 6 Inspectors and the average daily outturn of each *amin* was 26 acres and 17 fields. The entire area surveyed cadastrally lay in the Myaing township. Only 387 square miles consisted of cultivated land which contained 164,637 fields, the average size of the field being 1·5 acre. The remaining 218 square miles consisted of jungle in which no details were surveyed. The work was checked by 371 linear miles of test lines run by Imperial and Provincial officers, and 263 linear miles of independent *partals* which give an average of 1·6 linear miles of test survey by superior officers, to each square mile of the area actually surveyed. The small area surveyed topographically was that mentioned above, lying in the bed of the Irrawaddy which is subject to periodical inundation so that the fields change from year to year. The survey was done on the 16-inch scale to enable both the 16-inch and 2-inch maps to be completed. Only the *kwin* boundaries, limits of cultivation and water channels were mapped and the village sites, which are occupied during the dry season. The original maps, 53 in number, will be handed over to the Deputy Commissioner and no copies of them will be printed.

232. The 2-inch fair mapping of the season's work was completed. It falls into sheets 105, 106, 107, 108, 150 and 151, of which the two latter were forwarded to head-quarters. That of the Shwebo district, which was reported in arrears last season, was completed with the exception of 3 sheets, which could not be drawn as the 16-inch maps had been sent to Calcutta for reproduction. The whole of the Shwebo 16-inch maps have now been printed and copies supplied to the Land Records Department. Of the current season's work, however, the 16-inch maps of only 144 *kwins* out of 462 had been submitted for reproduction before the party resumed field work and no printed copies had up to that time been furnished to the local authorities.

233. A commencement has been made with the traverse charts of Burma and those of the following 23 standard sheets have been prepared, of which the first five have been sent to Calcutta for publication:—Sheet 149W and both sections of sheets 148, 196, 142, 143, 144, 145, 109, 152, 189, 190 and 191.

234. The cost-rates this season have returned to something like their normal figure and are considerably lower than those of last season when they were exceptional as was then explained. The rate for cadastral survey does not include the completion of the 16-inch maps which was somewhat in arrears at the close of the season. That of the traversing is 20 per cent lower than it has been during the last two seasons which is due to easier ground. All the rates include 4 per cent. for instruments.

235. *Rangoon Town.*—Mr. Smart was in charge of this survey and was assisted by Babu Jagdamba Prasad. The area for survey formed a fringe round the old municipal limits which had been surveyed in 1895—97 and as it also extended to both sides of the river, it was spread over a large tract of country. On the northern side where the main town is situated the ground was undulating

and covered with houses, mostly surrounded by gardens and trees, but on the other side it consisted of open rice-fields with a few mills and villages here and there. The south side, however, was subject to periodical inundation which interfered very much with the work at times. The traversing occupied 10 surveyors for two months and the average outturn of the traverse surveyors per working day was 7 angles and 26 chains. The chaining amounted to 195·7 linear miles and the theodolite was set up at 3,459 stations which were all marked with galvanized iron cylinders. Vertical angles were recorded throughout by means of which the heights of 1,600 stations were determined and the work was checked by observations for azimuth at 22 stations. Three new trigonometrical stations were also fixed and marked with masonry platforms surmounted by pillars in the shape of cubes of 1 foot sides.

236. The detail survey was done on the scale of 100 feet to the inch by 3 inspectors and 27 *amins* in five months. It was carried out in the usual way, but owing to the broken nature of the ground in the northern portion and to avoid the necessity of unnecessarily chaining across private enclosures, survey by interpolation was resorted to in that portion and 2,859 plane-table fixings were made. Extra heights were determined with the clinometer at 6,625 points and where the nature of the ground required it, approximate contours at 5-feet vertical intervals, were inserted by means of these heights and those furnished by the traversing. The number of sheets is 107 and the printed maps will be produced by the Vandyke process from the field sheets themselves which will all be completed and forwarded to head-quarters before the party takes the field again.

237. The expenditure on this survey during the season is ₹ 65,900 and during October 1905 a further sum of ₹1,663 was expended in completing the drawing of the maps and the area statements, bringing the total cost of the survey to ₹67,563 exclusive of the cost of printing the maps, which it is estimated will come to about ₹640. Excluding this, the cost per acre is ₹11·4. The average size of the plot is 0·26 acre.

238. *Programme.*—Next season the traversing of the Pakôkku district will be completed and 900 square miles will be surveyed cadastrally, leaving one season's work to complete the cadastral survey of the district.

UNITED PROVINCES OF AGRA AND OUDH.

No. 8 Party.

239. Captain W. M. Coldstream, R.E., continued as Superintendent of Provincial Surveys to supervise the operations in these provinces throughout the year, and as before the party consisted of one traverse and three cadastral camps and one drawing office. The operations of the previous seasons were continued and the total outturn of the party for the season is—

Traversing for cadastral survey	323	square miles.
New cadastral survey with records	349	"
Revision of cadastral maps and records	1,822	"
Supplementary topographical survey, scale 2 inches = 1 mile	167	"
Road surveys	1,364	linear miles.

also certain minor surveys which are given in detail below. The cadastral surveys were carried out by the agency of *patwáris*.

240. *Traversing.*—The area traversed, 323 square miles, lies in the riverain tracts of Moradabad district along the Ganges, where the main circuits had been measured during the previous season. The cost-rate, inclusive of ₹2-8 a share of head-quarter charges, is ₹26 per square mile. The traversing was connected with five stations of the Great Trigonometrical Survey and the average linear error per mile is 4·6 feet. Azimuth observations were taken at 48 stations and the angular error is 3·2 seconds per angle. The preliminary demarcation was good.

Personnel.

Mr. F. S. Bell, Extra Assistant Superintendent, 5th grade, in charge.

5 Traverse surveyors, 4 computers, 1 inspector, 7 *amins*, 7 road surveyors, 16 draftsmen, etc.

1904-05. BURMA. REVENUE SURVEYS.

INDEX TO THE SURVEY OPERATIONS IN BURMA NORTH OF LAT. 18°
REFERENCES.
Previous Seasons
Season 1904-05
Cadastral 16"
Topo. 8"
Do. 4"
Do. 2"
Do. 1"
Triangulated
Traversed
Revenue Survey Revised
Sheets Published
Province Boundary
District do.
NOTES.
The numerals 197, &c., indicate the Standard sheets on the Scale of 1 inch = 1 Mile.
The names of Towns surveyed on large Scales are underlined thus
MANDALAY.
Scale of Miles.
40 20 0 40
MYITKYINA
BHAMO
KATHA
KINDAT
MOGOK
LASHIO
SHWEBO
MONYWA
MANDALAY
MYINGYAN
PAKOKKU
MEIKTILA
YAMETHIN
TAUNGGYI
MINBU
MAGWE
AKYAB
KYAUKPYU
THAYETMYO
PROME
SANDOWAY
PAKOKU
Kyaukse
Mong Nai
Mong Hsu
Kengtung
Mong Hsat
Mong Pan
Loilem
Mong Pawn
Mong Yang
Mong Kung
Mong Kham
Kyaingtong
Mong Yai
Mong Tung
Hsenwi
Hsipaw
Lawksawk
Yawnghwe
Mong Pai
Mong Nawng
Mong Mit
Mong Wi
Kyaukme
Nam Tu
Nam Pawk
Nam Hpakka
Nam Hkam
Nam Hsan
Nam Pan
Nam Tok
Nam Hpa
Nam Hsu
Nam Ma
Nam Kham
Nam Hkok
Nam Hsa
Nam Hsim
Nam Hsai

1904-05

BURMA.

REVENUE SURVEYS

INDEX TO THE SURVEY OPERATIONS IN BURMA SOUTH OF LAT. 18°

REFERENCES.

	Previous Seasons	Season 1904-05
Cadastral 10"		
Topo. Survey 8"		
Do. do. 4"		
Do. 2"		
Do. 1"		
Triangulated		
Traversed		
Revenue Survey Revised		
Sheets Published		
Provence Boundary		
District		

NOTES.

The numerals 266, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

The names of Towns Surveyed on large Scales are underlined thus RANGOON.

Scale of Miles.

40 20 0 40

Reg. No. 1019-S. 05.

UNITED PROVINCES.

1904-05.

INDEX TO TRAVERSE SURVEY.

Published under the direction of Colonel H. B. Thuillier, R.E., Surveyor General of India.

Survey of India Offices Calcutta, Sept. 1905.

Reg. No. 840-S. 06.

UNITED PROVINCES.

1904-05.

INDEX TO CADASTRAL SURVEYS.

241. A traverse was also run along the Allahabad-Rewah boundary in order to fix the sites of the boundary pillars and to provide a basis for the cadastral survey of a strip of ground along the boundary. The length of the traverse was 98 miles and the cost-rate R9·7 per linear mile. The work was difficult and rather expensive, as the line runs over a low range of hills for a considerable portion of its length. Azimuth observations were taken at 52 stations, the mean angular error being 2·6 seconds per angle.

242. The traverse camp also revised in the field the 64-inch maps of Cawnpore city and environs, covering an area of 8·4 square miles, brought up to date the cadastral maps of certain estates of an aggregate area of 1·7 square miles in Cawnpore for the Settlement Department, surveyed and mapped on the scale of 24 inches to the mile 1·6 square miles of the lands of the Hápur Remount Depôt, prepared general maps on the 16-inch scale of Fyzabad and Ajodhya towns from recent surveys, and surveyed on the 64-inch scale the boundaries of 1,364 linear miles of 1st class roads for the Public Works Department.

243. *Moradabad.*—The programme of cadastral survey and revision in this district was practically completed. Operations were commenced in October 1903, and have included the re-survey of 860 square miles in *tahsils* Moradabad, Thákurdwára, Amroha, Hasanpur and Sambhal, and the revision of maps in the last three *tahsils*, covering an area of 406 square miles, of which 349 square miles of resurvey and 320 square miles of map revision were done this season. The cost-rate for the district is R37 for survey and revision and R22 for record writing. The district was traversed and cadastrally surveyed in the years 1871-76, but in the riverain tracts the old traverse stations had disappeared and fresh traversing was necessary. The cost-rates for the season are R40·4 for survey and revision of maps and R17·9 for record-writing. The average size of the fields is 0·8 acre. The maps were checked by an average of 4·4 linear miles of test survey per square mile, including 1·75 linear miles per square mile run by supervising officers and independently. Of the 185 *patwáris* trained, 43 failed to qualify, 29 were allowed to provide their heirs to do the work, and substitutes had to be provided for 14. In addition to the *patwáris*, 19 *kánungos*, 33 partition *amins* and candidates, and 26 students of the Agricultural College, Cawnpore, were trained in survey. At the request and expense of the municipality a survey on the 64-inch scale was made of the town of Moradabad, the civil lines being done on the 16-inch scale. The area surveyed on the larger scale is 1,055 acres, and on the smaller 1,702 acres, and the cost-rates are R1·9 and 9 annas per acre respectively. This includes the cost of the traversing and the printing of the large scale sheets and of a general map on the 16-inch scale, but does not include any charges for supervision, and no records or area statements were prepared.

Personnel.

Mr. L. F. Berkeley, Extra Assistant Superintendent, 3rd grade, in charge.
Mr. J. H. Murphy, Extra Assistant Superintendent, 5th grade.
3 Head Inspectors, 17 inspectors, 240 *patwáris*, etc.

Bánda.—Cadastral operations were commenced in October 1903, and will be completed in November 1907. Up to date the maps in *tahsils* Bánda, Pailáni, Baberu and Kamásin have been revised, and those of Girwan, Badausa, Mau and Karwi remain for revision during the next two years. The areas in which the maps have been revised and new annual records written during the year, are 362 square miles in *tahsil* Baberu, and 358 square miles in *tahsil* Kamásin, making a total of 720 square miles. The cost-rates are R26 per square mile for survey and R17 for record-writing. The average size of the fields is 1·0 acre nearly. Owing to the serious interruptions caused by the withdrawal of the *patwáris* from survey duty to estimate damage done by frost to crops, the whole of the village records for the year cannot be completed and made over to the Settlement officer for some months to come, but the arrears will not be so serious as to delay attestation. The traverse stations of the survey of 1874-1877 were permanently marked by stones which are in good preservation.

Personnel.

Mr. F. B. Powell, Extra Assistant Superintendent, 5th grade, in charge.
Babu Nilmoni Chatterji, Extra Assistant Superintendent, 6th grade.
2 Head Inspectors, 15 inspectors, 207 *patwáris*, etc.

An average of 4·3 linear miles of test survey was applied per square mile, including 1·5 linear miles per square mile run by supervising officers and independently. Of 184 *patwáris* trained, 17 failed to qualify, 7 were allowed to provide their heirs to do the work, and substitutes had to be provided for the other 10. Mr. J. B. Smart, Deputy Collector, was attached to this camp and trained in all branches of the work, and 13 *kánungos* and 29 local men were trained in survey. A survey was made of the town of Bánda on the 64-inch scale at the cost of the municipality. The area surveyed is 902 acres, and the field work was completed at a cost of R1,203, which includes traversing but does not include any charges for supervision.

244. *Hamirpur.*—The revision of the cadastral maps was commenced in October 1903, and will be completed next season. Up to date *parganas* Hamirpur, Sumerpur, Maudha, Ráth, Jálálpur and Maskara have been dealt with, and Mahoba *tahsil* remains for 1905-06. During the year the maps of *parganas* Ráth, Jalálpur and Maskara, comprising an area of 782 square miles, have been corrected, and new annual records written. The average size of the fields is 1·9 acre. The cost rates for the year are R30 per square mile for map correction and R20 for record writing. The *patwáris* were withdrawn from survey work for considerable periods at different times for work connected with damage to crops and for other purposes. Owing to these causes field work did not close till August, and although a sufficient number of records will be ready for attestation to begin in November or December 1905, the whole of the records cannot be completed till February 1906. The maps have been checked by an average of 4·5 linear miles of test survey per square mile, of which 1·7 linear miles per square mile were run by supervising officers or independently. The traverse stations of the last survey of 1874-79 were not permanently marked, and except those at trijunctions of village boundaries, very few have been found; this has enhanced the difficulty of the work and will render map maintenance in future very arduous. Out of 195 *patwáris*, 33 failed to qualify in survey, 19 of these were allowed to provide their heirs to do the work, and local substitutes were provided for 14. Thakur Lekhraj Singh, Deputy Collector, was attached to the section in February for training.

Personnel.

Mr. P. C. Smart, Extra Assistant Superintendent, 3rd grade.
Mr. C. S. Littlewood, Sub-Assistant Superintendent, 1st grade.
2 Head inspectors, 9 inspectors, 253 *patwáris*, etc.

245. *Drawing Office.*—Fourteen standard sheets, No. 101, 102, 115, 116, 129, 130, 131, 132, 144, 145, 146, 53, 54, 55, have been compiled on the 2-inch scale for reduction to one-half by photography, and twenty-one maps of the 2-inch topographical survey of Meerut of 1878 to 1882 have been revised from the maps of modern Cadastral surveys. Two district maps of Meerut and Pilibhít have been completed on the ½-inch scale for reduction to one-half, and submitted for publication, 16 traverse charts of sheets 69E, 70E, and both sections of 81, 82, 83, 84, 86, 99, and 100 were drawn and submitted, and 22 plane table sections were compiled on the 2-inch scale from the cadastral maps of Farrukhabad, Etáwah and Jálaun for supplementary survey by a topographical party.

Personnel.

Mr. J. Kennedy, Extra Assistant Superintendent, 3rd grade, in charge.
Mr. W. C. Price, late Extra Deputy Superintendent (retired), temporarily re-engaged.
1 Surveyor, 2 probationer surveyors, 44 draftsmen, etc.

246. Three plane-tablers were employed on topographical survey on the 2-inch scale to supplement and fill in gaps in the cadastral surveys, and on the topographical survey of certain roads and railways in districts Meerut, Sitapur and Bahraich, and of the riverain areas along the Gogra in Bahraich, Kheri and Sitapur. Their total outturn was 167 square miles and 200 linear miles of railways and roads.

247. During the field season, the Superintendent inspected the cadastral field work and survey offices in Moradabad, Hamirpur and Bánda, conducted a class of 10 officers of the Indian Civil Service, checked the topographical work in Meerut and Bahraich, and inspected the office of the traverse section at Moradabad. During the recess he again inspected all four offices.

248. The cadastral map correction remaining to be done in Bánda and Hamirpur, and the miscellaneous work of the traverse section, will be transferred

in October to the direct supervision and control of the Land Records Department, and Captain Coldstream and 4 officers of the Provincial Service will be replaced at the disposal of the Surveyor General.

249. The Drawing Office will be retained for another year to continue the compilation of preliminary editions of standard sheets from cadastral maps and the preparation of plane-table sections for supplementary topographical survey.

ASSAM DETACHMENT.

Personnel.

Mr. T. Shaw, Extra Deputy Superintendent, 2nd grade, in charge.
Mr. F. P. Walsh, Extra Assistant Superintendent, from 17th January to 30th June 1905.
Mr. C. A. O'Donel, Extra Assistant Superintendent, up to 19th January 1905.
5 Traverse surveyors, 2 computers, 8 draftsmen.

250. During this season the work of this detachment was confined to traverse and boundary surveys and standard mapping. The outturn of field work during the season is shown in the following statement:—

District.	Traversing for cadastral survey on the scale of 16 inches = 1 mile.		Traversing and boundary survey of Tea grants.		Total square miles.	Linear miles.
	Number of villages.	Square miles.	Number of grants.	Square miles.		
Nowgong . .	...	...	3	1·08	1·08	44·70
Sibságar . . .	...	...	7	7·40	7·40	34·84
Lakhimpur . .	51	20·27	45	51·40	71·67	424·26
	51	20·27	55	59·88	80·15	503·80

In addition to the above, 28 linear miles of traversing were measured along the Dibru-Sadiya railway between Makum junction and Ledo coal mines station. The linear miles given in the above statement includes 153 miles of lines connecting grants and villages with one another and with previous seasons' surveys. Out of 4,061 stations at which the theodolite was set up, 50 were marked with stone prisms, 209 with masonry pillars and the rest with wooden pegs, and at 3,090 stations previously marked by wooden pegs *sémal* trees were planted five feet north of each station. As there are no regular village boundaries in Assam, the traversing for cadastral survey was confined to cultivated lands and village sites and any small blocks of intervening waste which could not conveniently be omitted.

251. As the work done by this detachment is of an exceptional nature, no useful purpose would be served by discussing the cost. During the year seven standard sheets were submitted for publication and nine district maps on the scale of 1-inch = 8 miles for the gazetteer were drawn. Mr. Shaw conducted two Survey school examinations for first class certificates at Gauháti and Jorhát and also examined 15 Pleaders in surveying and 13 *patwári* candidates.

252. It is intended to close the drawing office from December 1905, when the whole of the material available from recent surveys for the correction of the standard sheets will have been utilized. The detachment will then cease to exist and the few traversers and computers remaining will be placed at the disposal of the local Government to continue traversing for cadastral and Tea grant purposes. Mr. Shaw will also remain in the province for the present to carry on the work of maintenance of land records until he can be replaced by an officer of the Provincial Civil Service whose appointment awaits the sanction of the Secretary of State.

ASSAM.

INDEX TO RECENT CADASTRAL, TRAVERSE, & TOPOGL. SURVEYS IN THE BRAHMAPUTRA & SURMA VALLEYS.

1904-05. ASSAM DETACHMENT.

Published under the direction of Major T. H. Lodge, R.E., Officiating Surveyor General of India.

Engraved at the Survey of India Office, Calcutta, 1907.

Reg. No. 631-S. 06.

TRIGONOMETRICAL SURVEYS.

INDIA TRIANGULATION.

NO. 24 PARTY.

253. The party was under the charge of Captain H. H. Turner, R.E., throughout the year under review.

Personnel.

Captain H. H. Turner, R.E., Deputy Superintendent, 2nd grade, in charge.
Mr. D. J. Hunter, Sub-Assistant Superintendent, 1st grade.
Mr. C. D. Simons, Sub-Assistant Superintendent, 2nd grade.
3 Recorders, 1 writer, 1 hospital assistant.

254. The programme of field work consisted of the commencement of a new series of triangulation in Baluchistan. As there was no principal series in the neighbourhood of Quetta on which to base the new series, the latter was started from a secondary base and a connection with the Indian Principal Triangulation was left to a future date. The need of good triangulation in Baluchistan was so great that the above compromise had to be made.

255. The party took the field in the first week in October and, after a march of 87 miles to Kalát, the work of building stations was commenced. Owing to no stations being ready, observations could not be commenced till the 25th October. From that date observations were continued to the 7th March.

The recess quarters were reached on the 3rd April. After this date, however, further field work was carried out. The triangulation round Mussooree was revised in order to test whether there had been any permanent displacement of the hills due to the earthquake shock of April 4th. Observations were also taken from Banog H. S. to the snowpeaks for the investigation of the co-efficient of refraction to be used in calculating their heights.

256. During the recess the computations were completed, the seasons outturn of work being—

Principal Triangulation.

Number of stations newly fixed	8
Number of figures completed	2
Length of series completed in miles	130
Area of triangulation in square miles	2,464
Number of stations at which astronomical Azimuths were observed	1
Mean triangular error (9 triangles)	667

Secondary Triangulation.

Number of stations newly fixed	*nil.*
Number of figures completed	1
Length of series completed in miles	10
Area of triangulation in square miles	120
Mean triangulation error	1'47

257. The Superintendent, Trigonometrical Surveys, inspected the party on September 13th.

SCIENTIFIC OPERATIONS (GEODETIC).

ASTRONOMICAL LATITUDES.

NO. 22 PARTY.

258. Captain H. M. Cowie, R.E., accompanied the Tibet Frontier Mission to Lha-sa in the summer of 1904; on his return to No. 22 Party (Astronomical) in November he was employed for some weeks in computing the results of triangulation in Tibet and in drawing the fair sheets. The Astronomical party did not therefore take the field until December 1904. A programme was designed to furnish certain results which were urgently required to supplement the existing

Personnel.

Lieutenant-Colonel S. G. Burrard, R.E., F.R.S., Superintendent, in charge up to 13th November 1904, and again from 18th March 1905.
Captain H. M. Cowie, R.E., Assistant Superintendent, 1st grade, in charge from 14th November 1904 to 17th March 1905.
1 Computer, 1 surveyor.

astronomical data of Lower Burma. During the field season Captain H. M. Cowie, R.E., observed for latitude at the four longitude stations of Lower Burma and for azimuth at Nagarkhána, a station near Chittagong. An azimuth had already been observed at Dattaung Taungzun and Kyaunggyi which were near the Akyab, Moulmein and Prome Longitude stations respectively.

TABLE OF RESULTS.

Latitudes.

Series.	Station.	Height above mean sea level.	Longitude.	Astronomical Latitude=A.	Geodetic Latitude=G.	Probable Error.	Deflection of the plumb-line= A—G.
		Feet.	° ′	° ′ ″	° ′ ″	″	″
Burma Coast	Moulmein	90	97—40	16 30 2·97	16 29 54·62	±0·113	+8·35
	Prome	100	95—15	18 49 18·62	18 49 14·18	±0·101	+4·44
	Akyab	20	92—56	20 8 14·87	20 8 12·86	±0·063	+2·01
	Nagarkhána	290	91—51	22 22 57·08	22 22 56·38	±0·059	+0.70

Azimuths.

Series.	Observing Station.	Astronomical Azimuth=A.	Geodetic Azimuth=G.	A—G.	Station observed.
		° ′ ″	° ′ ″	″	
Burma Coast	Dattaung	171 27 28·29	171 27 31·93	−3·64	Bengara.
	Taungzun	31 16 18·58	31 16 31·77	−13·19	Kaulah.
	Kyaunggyi	109 26 42·1	109 26 48·1	−6·0	Prome.
	Nagarkhána	155 47 13·34	155 47 21·99	−8·65	Chandarnáth.

259. Latitude observations were also taken at Dehra Dún (Haig observatory) station, the result of which is exhibited in following table:—

TABLE.

Station.	Date.	Astronomical Latitude=A.	Geodetic Latitude=A.	Deflection of the plumb-line= A - G.
Dehra Dún (old Survey Office).	April 1852	30 19 19·56	30 19 57·07	−37·51
Dehra Dún (Base line East End)	November 1892	30 16 37·26	30 17 7·35	−30·09
Dehra Dún (Haig observatory)	December 1904 and March 1905.	30 18 51·90	30 19 28·73	−36·93

PENDULUMS.

NO. 23 PARTY.

260. During the season 1904-05 the party was engaged in making pendulum observations at a number of stations situated on or near the meridian of Calcutta.

Personnel.

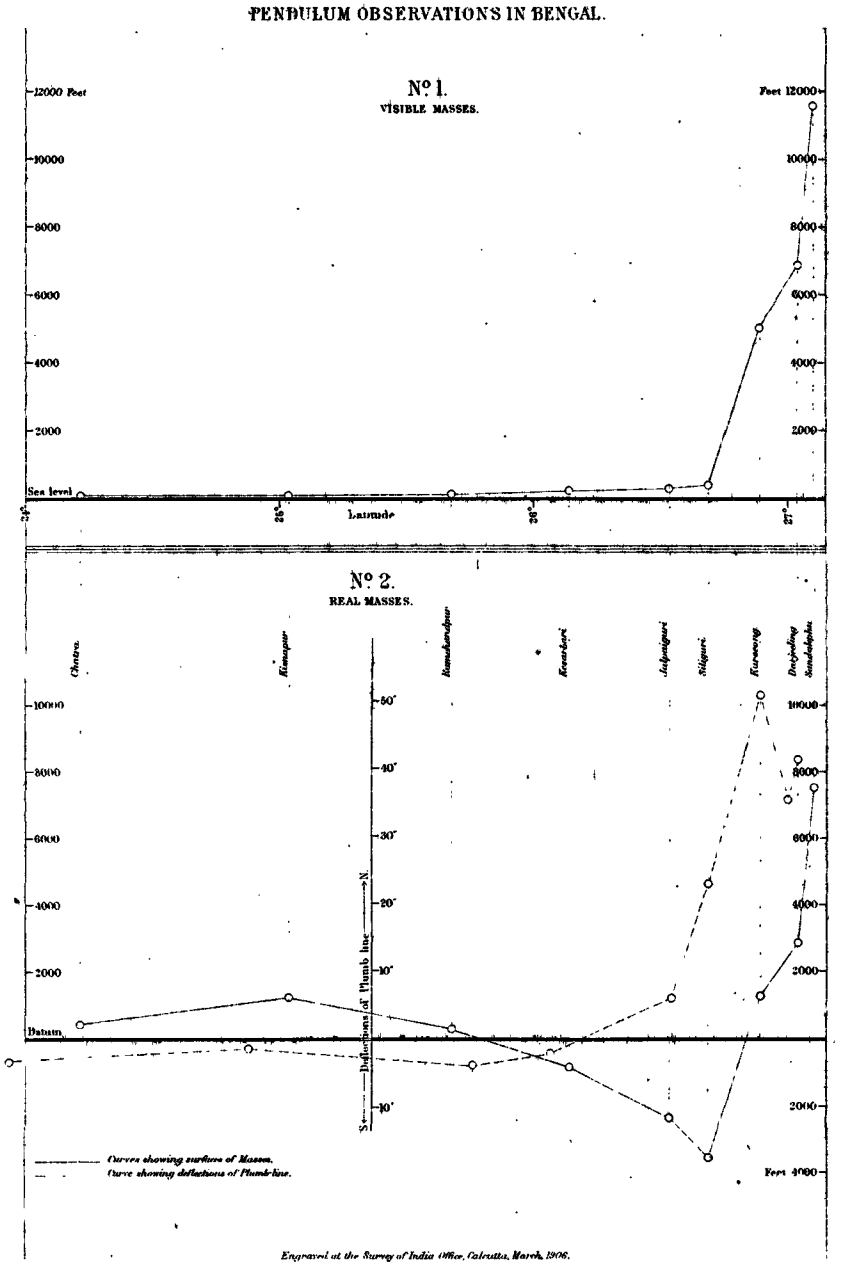
Major G. P. Lenox Conyngham, R.E., Superintendent, 2nd grade, in charge, Babu Hanuman Prasad, Sub-Assistant Superintendent, 1st grade, 2 surveyors and Computers.

261. The new pendulum apparatus was used for the first time under field conditions. At the majority of the stations visited houses of more or less suitable character were available, but at four recourse had to be had to a tent. The variations of temperature which are unavoidable in a tent were a source of anxiety and Major Lenox Conyngham is of opinion that for the future where houses are not available, it will be desirable either to build a temporary hut or in some way to supplement the protection afforded by a tent.

DIAGRAMS

ILLUSTRATING THE RESULTS OF

PENDULUM OBSERVATIONS IN BENGAL.



Engraved at the Survey of India Office, Calcutta, March 1906.

261. In the following table the results of the observations are given :—

Station.	Latitude.	Height above sea level.	Observed g.	g reduced to sea level $= g_0''$.	Theoretical value of g at sea level.	$g_0'' - \gamma_0$
		Feet.				
Cuttack . .	20 29 5	92	978·653	978·669	978·636	+ 0·033
Chatra . .	24 12 40	64	·873	·884	·873	+ ·011
Krishnapur . .	25 2 26	113	·958	·965	·930	+ ·035
Ramchandpur .	25 40 57	132	·972	·980	·975	+ ·005
Kesarbari . .	26 7 41	204	·955	·967	979·007	— ·040
Jalpaiguri . .	26 31 16	268	·924	·940	·035	— ·095
Siliguri . .	26 41 47	387	·850	·913	·048	— ·135
Kurseong . .	26 52 51	4,915	·628	·932	·062	— ·130
Darjeeling . .	27 2 47	6,966	·503	·931	·074	— ·143
Sandakphu . .	27 6 6	11,765	·193	·931	·078	— ·147

The values of g are based on the value 979·065 at Dehra Dún, which in turn depends on the value 981·200 at Kew.

In reducing to sea level the three corrections, for height, intervening mass and inequality of surface, have all been applied. The calculation of the last which is called the orographical correction was a laborious piece of work. The methods elaborated by Captain Basevi and Colonel Herschel were followed, though some modifications tending to simplicity were introduced.

The pendulums seem to have suffered a very slight diminution in length during the field season, producing a change in the time of vibration of the mean pendulum of 0·0000013 sec. The effect of such a change on the deduced value of g is 0·005 c.m.

There is no evidence of the change being greater in one pendulum than in the others, and it is impossible to say whether it has taken place gradually or suddenly. Under these circumstances it has been thought best to use the mean of the two values of the time of vibration at Dehra Dún, the one determined before and the other after the tour, in deducing the value of g at the other stations.

The points of interest in the season's results are—

1. The considerable excess of g_0'' over γ_0 about latitude 25°.

2. The very large defect in g_0'' at Siliguri at the foot of the Himalayas.

3. The fact that the deficiencies in g_0'' at the Himalayan stations, though considerable, are very much less than that indicated by Captain Basevi's observations at Moré. His result could only be interpreted by supposing that the great apparent mass of the Himalayas was entirely compensated by deficiencies of matter in the underlying parts of the earth's crust, whereas the deficiency at Sandakphu corresponds to a compensation of only about one-third of the visible mass; that is to say, if the strata underlying Sandakphu were compressed until the height of that station was reduced from 11,766 to 7,586, they would then be of normal density, namely, 2·8.

When a section of the country traversed is drawn to show the real masses revealed by the pendulum, the deflections of the plumb line found by Captain Cowie in 1901-02 become intelligible, though without a greater number of pendulum stations it would not be possible to account for them completely.

262. The party was inspected by the Superintendent, Trigonometrical Surveys, in September 1905.

TIDAL AND LEVELLING OPERATIONS.

No. 25 Party.

Tidal Operations.

263. Major J. M. Burn, R.E., held charge of the Party from 2nd November 1904 to 10th July 1905, when he took 1 month and 15 days' privilege leave; and from 25th August 1905 to 15th September 1905, on which date he proceeded on privilege leave combined with furlough on medical certificate.

Personnel.
Major J. M. Burn, R.E., Deputy Superintendent, 1st grade.
Mr. J. P. Barker, Extra Assistant Superintendent, 4th grade.
Mr. H. G. Shaw, " " " 5th "
Mr. E. H. Corridon, Sub-Assistant Superintendent, 1st grade.
Munshi Syed Zille Hasnain, Sub-Assistant Superintendent, 1st grade.
1 Surveyor, 19 computers, 2 native artificers and 4 tidal clerks.

Mr. J. P. Barker held charge from 1st October 1904 to 1st November 1904, from 11th July 1905 to 24th August 1905 and from 16th September to 30th September 1905.

264. Observations were taken by means of self-registering tide-gauges, during the year, at the stations given in the following list. The permanent stations are shown in italics :—

	Stations.	Automatic or Personal observations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.	Remarks.
1	*Aden*	Automatic	1879	Still working	25	
2	*Karáchi*	"	1881	"	24	
3	Okha Point	"	restarted 1874	1875	1	
			restarted 1904			
4	*Bombay (Apollo Bandar)*	"	1878	still working	27	Property of Port Trust.
5	*Bombay (Prince's Dock)*	"	1888	"	17	
6	*Madras*	"	1880	1890	10	20
			restarted 1895	still working	10	
7	*Kidderpore*	"	1881	"	24	
8	*Rangoon*	"	1880	"	25	
9	*Port Blair*	"	1880	"	25	

In addition to the above, readings to tide-poles were taken at Bhávnagar, Chittagong, Akyab and Moulmein.

265. All observatories, where there are tide-gauges, were inspected during the year. The registrations at these observatories have been satisfactory, excepting Okha, where there was a break in the record from 6th November to 26th December. The gauge has since worked well. Readings to tide-poles were taken under the direction of port officers.

266. The two following tables show the annual and decadal percentages of the predicted time and height, errors of high and low water at open coast and riverain stations:—

Percentage of errors in predicted times and heights at open coast stations from automatic registrations.

Year.	Number of Stations.	In time.		In height.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1895	9	68	65	98	97	94	94
1896	9	71	70	97	97	97	93
1897	8	71	75	96	97	97	97
1898	9	74	70	96	96	95	95
1899	9	74	66	95	95	93	92
1900	11	66	60	93	88	93	89
1901	11	71	60	93	91	93	91
1902	9	76	67	94	95	96	96
1903	8	80	77	92	93	94	94
1904	6	82	75	99	98	96	96
Average of 10 years	9	73	69	95	95	95	94

Percentage of errors in predicted times and heights at riverain stations from automatic registrations.

Year.	Number of Stations.	In time.		In height.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1895	2	59	55	74	47	94	84
1896	2	56	55	63	42	87	74
1897	2	59	61	75	57	96	91
1898	2	53	59	71	61	90	91
1899	2	55	59	76	65	95	94
1900	2	59	62	70	57	89	87
1901	2	63	65	70	59	90	92
1902	2	63	54	76	53	96	90
1903	2	55	61	70	60	88	87
1904	2	45	61	72	65	94	95
Average of 10 years	2	57	59	72	57	92	89

267. A reconnaissance of the Malay Peninsula near Kedah was made with the object of finding suitable sites for tidal observatories, but ended in failure. It has been found that the whole of the west coast is unfavourable for the establishment of observatories, and the scheme of carrying out tidal operations in the Peninsula has therefore had to be abandoned.

Preparations are being made for the reopening of a tidal observatory at Moulmein. It is now 19 years since this observatory was closed. The results derived from the observations which will now be obtained will serve as a check on the accuracy of the predictions and will be of benefit to both science and commerce.

Active measures will be taken to establish an observatory near Suakin. It is hoped that the observations will be productive of results which, in conjunction with those already obtained at Suez and Perim, will be of great help to the scientific investigations of the tides of the Red Sea.

SPIRIT LEVELLING OPERATIONS.

268. The Levelling Detachment was employed in Sind and in the Dehra District. In Sindh levels were taken between Sujáwal and Sukkur; in Dehra the short line from Dehra to Mussooree was revised.

The levelling in Dehra was done with the object of discovering any change in level which may have been caused by the earthquake of 4th April.

The total outturn of work was 318 miles.

The field season commenced on 21st October 1904 and closed on 15th June 1905.

Standard bench marks were erected at 19 towns in the United Provinces, one in Gwalior and one in Jhánsi.

A second levelling detachment has been organised and the detachments are designated Levelling Detachment No. 1 and Levelling Detachment No. 2.

During the coming field season detachment No. 1 will take levels across the Brahmaputra between Dhubri and Fakírganj and then connect the standard bench marks in the United Provinces with already existing bench marks. Detachment No. 2 will level from Sukkur to Shikárpur across the Indus and then from Lahore to Chach Base, connecting bench marks at three cantonment stations.

MAGNETIC.

No. 26 PARTY.

269. During the year under report satisfactory progress has been made with the work of the magnetic survey: the five base stations are now in working order with the equipment originally contemplated: they cannot however be considered fully equipped until the vertical force instruments are installed: two of these have arrived in India while the remaining two (excluding Colaba where a vertical force instrument is already in operation) are expected shortly.

Personnel.

Major H. A. D. Fraser, R.E., Deputy Superintendent, 1st grade, in charge up to 20th March 1905.
Captain R. H. Thomas, R.E., Officiating Assistant Superintendent, 1st grade, in charge from 21st March 1905.
Mr. E. C. J. Bond, Extra Assistant Superintendent, 6th grade, from 20th April 1905.
Mr. H. P. D. Morton, Sub-Assistant Superintendent, 1st grade.
Babu R. P. Ray, " " " 2nd "
Mr. A. M. Talati, " " " " " up to 8th May 1905.
Mr. E. A. Meyer, Sub-Assistant Superintendent, 2nd grade.
Babu N. R. Mazumdar, " " " "
12 Observers, computers and recorders, 1 surveyor and 1 writer.

270. The field season commenced on the 20th October and ended early in May when the party moved to recess quarters. Four field detachments were employed during the work season. The field observations were taken chiefly in Rajputana, the Central Provinces, Nizam's dominions, parts of Madras and the coast line from Mangalore to Cutch. Railways could be utilized but little, and the intervals between stations were mostly covered by marching. The total number of new stations was 206.

271. The two Imperial officers erected the self-recording instruments at Toungoo in December 1904, and in addition observed at 5 new and 4 old repeat stations and at the five base stations.

272. The total number of stations observed to date in four working seasons is 808 with 22 repeat stations: it is expected that the preliminary survey, including the extension of the work into the more easily accessible hill districts, will be completed in three more seasons with four field detachments. Most of the work, however, lies in difficult country, and progress will be distinctly slower than in former years.

273. Magnetometers behaved uniformly well in the season under review and the results from them were up to the standard laid down, but the dip circles in some instances gave considerable trouble in spite of their having been put in thorough working order at the beginning of the field season. Under ordinary observatory conditions, dip observations cannot be relied upon within $\pm$ 2 minutes, and in view of the approaching installation of the vertical force instruments, an earth inductor of the Schulze pattern has been ordered for Dehra Dún base station.

274. In 1903-04 the log π^2K observations revealed marked changes; the two standard inertia bars were therefore remeasured at Kew in 1905. It was

found that both bars had lost weight, but the cause remains unexplained. The absolute moments of inertia of the bars (irrespective of the dimensions) were determined at Kew by Professor Watson's method.

The Magnetic Survey is indebted to Professor Watson for the gift of a new standard inertia bar. In order to detect in future any change in weight either in the bars or magnets, sanction has been asked to the purchase of a delicate balance; any change in the observed weight of a system will then indicate the desirability of redetermining its moment of inertia.

275. The party proceeded to recess quarters on the 7th May 1905 and the computation of the field work has been completed and abstracts of results made. Good progress has also been made with the tabulation and reduction of the base station results for 1904, which will be published in the next annual report.

276. The earthquake of the 4th April last was registered on the magnetographs at all the base stations, while at Dehra Dún the shock was sufficiently violent to throw the declination instrument out of adjustment, and even at Barrackpore the displacement was so great that the declination magnet adhered to the side of the box and it was necessary to introduce a bar magnet into the room to restore it to its normal position. The shortness of the time scale on the magnetograph traces (on which 1 hour is represented by ·6 inches) precludes any very accurate measurement of the exact time of arrival of seismic waves; the indications are therefore of no great value as far as the investigation of the speed of such waves is concerned, and the results deduced from the various observatories can only be regarded as an approximation. There appears, however, to be sufficient evidence to show that even so close to the origin as 130 miles, magnetograms do not record preliminary tremors.

277. *Dehra Dún Observatory.*—The horizontal force instrument has given good results throughout the year, but the declination has required adjustment on two occasions, including that after the earthquake.

The vertical force pillars were erected in July last and the instrument itself in August. Experiments for the elimination of the temperature co-efficient are now in progress.

278. *Barrackpore Observatory.*—The instruments have worked satisfactorily throughout. The site is unhealthy and the observer who has suffered considerably from sickness is being transferred to Dehra Dún. The vertical force instrument for Barrackpore has arrived, and it is hoped opportunity will offer to erect it during the cold weather.

279. The observer at Kodaikánal resigned his appointment in April last, but through the good offices of the Director, Solar Physics Observatory, a suitable incumbent was obtained locally. The declination instrument again gave trouble through interference and it was opened up in December last. Nothing in the shape of fungoidal growth could be detected, but the instrument was taken to pieces, the parts thoroughly washed with percloride of mercury and re-erected, since when the results have been satisfactory. It is noteworthy that the horizontal force magnetograph has not exhibited signs of this derangement.

280. *Toungoo Observatory.*—The instruments were installed in December last year, and several experiments carried out for determining the temperature co-efficient of the horizontal force system. These were not altogether satisfactory, and after the lapse of some weeks a solution was indicated in the rapid loss of moment evident in the horizontal force magnet. As it appeared probable that this was due to the manufacturers having omitted to "age" the magnet, the observatory was recently visited and the operation carried out. It is hoped that the magnetic moment is now stable and further experiments to determine the temperature co-efficient will be carried out next field season.

281. A beginning has been made with the investigation of the reduction formulæ for the field observations by Mr. J. Eccles, M.A., on lines suggested by Sir A. Rucker. In order to reduce the magnitude of the corrections for diurnal variation, observers will not work between 9 A. M. and 3 P. M. in future.

282. A table showing the approximate preliminary values (uncorrected) of the magnetic elements at the stations of observation of the field season 1904-05 is appended, together with a reference index map.

283. During the next field season operations will be carried on by four field detachments. Two detachments will work in Chota Nagpur, Orissa and the Agency tracts, one will work on the Eastern Bengal and Assam-Bengal Railways, while the fourth will be employed in filling up gaps left in previous seasons.

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season 1904-05.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
603	Shahabad	8	25 14 40	77 9 40	35 0	E 1 40	0·3530	
604	Barágaon	9	25 40 10	77 3 10	35 45	„ 1 40	0·3515	
605	Birpur	10	26 7 30	77 8 20	36 30	„ 2 5	0·3515	
606	Manakhoar	11	26 24 30	77 16 10	37 5	„ 2 20	0·3560	
607	Gangapur	6	26 28 50	76 44 20	37 5	„ 2 10	0·3485	
608	Jhalai	7	26 21 30	75 59 50	36 35	„ 2 5	0·3510	
609	Málpura	8	26 17 0	75 22 10	36 40	„ 1 50	0·3480	
610	Awan	9	25 48 0	75 36 20	35 55	„ 1 55	0·3495	
611	Indargarh	10	25 43 50	76 11 0	35 50	„ 1 45	0·3505	
612	Kotah	11	25 11 30	75 51 40	35 10	„ 1 45	0·3530	
613	Singoli	6	24 58 10	75 17 20	34 35	„ 1 40	0·3520	
614	Rámpura	7	24 27 40	75 36 40	33 20	„ 1 35	0·3570	
615	Jhalra Pátan	8	24 36 0	76 9 20	33 55	„ 1 25	0·3550	
616	Kundio	9	24 2 0	75 53 30	32 25	„ 1 40	0·3570	
617	Khilchipur	10	24 2 0	76 34 20	32 40	„ 1 20	0·3600	
618	Naiakila	8	24 3 40	77 15 30	33 50	„ 2 15	0·3475	
619	Thuria	7	22 46 10	76 41 20	30 0	„ 0 20	0·3625	
620	Hat-Piplia	8	22 46 0	76 17 10	31 5	„ 0 30	0·3550	
621	Bistan	9	21 41 50	75 40 10	27 10	„ 1 5	0·3775	
622	Khal Ghat	10	22 8 50	75 27 10	34 0	„ 2 35	0·3195	
623	Dhár	11	22 36 0	75 18 30	29 35	„ 0 50	0·3670	
624	Chikalda	11	22 5 0	74 52 40	28 45	„ 0 55	0·3635	
625	Sondwa	12	22 7 10	74 22 20	28 15	„ 1 10	0·3620	
626	Artia	13	22 2 40	73 58 20	30 10	„ 0 30	0·3650	
627	Jawhár	9	19 54 0	73 13 30	24 50	„ 0 25	0·3680	
628	Girdon	10	20 5 20	73 25 50	26 5	„ 0 55	0·3630	
629	Peint	11	20 15 20	73 29 10	25 30	„ 0 45	0·3675	
630	Baphlun	12	20 32 50	73 29 30	25 45	„ 1 15	0·3640	
631	Kanási	13	20 31 30	73 52 0	25 35	„ 1 5	0·3655	
632	Jáykheda	14	20 47 40	74 12 10	26 25	„ 0 55	0·3675	
633	Lawa	10	25 14 10	73 59 30	35 5	„ 1 50	0·3595	
634	Bichabhera	5	24 16 20	73 22 50	33 5	„ 1 20	0·3545	
635	Dhambolia	6	23 42 10	73 19 50	32 10	„ 1 15	0·3555	
636	Debhári	7	23 15 20	73 30 10	31 5	„ 1 15	0·3580	
637	Ghatanogam	8	23 35 30	73 53 50	31 45	„ 1 25	0·3570	
638	Bánswára	9	23 33 10	74 25 50	31 45	„ 1 40	0·3590	
639	Mánpur	10	23 59 50	74 14 40	32 45	„ 2 0	0·3590	
640	Kánar	11	24 26 0	74 16 10	33 20	„ 1 45	0·3540	
641	Silwáni	9	23 18 20	78 26 20	30 20	„ 0 55	0·3700	
642	Gourjhámar	10	23 31 30	78 56 0	31 45	„ 1 5	0·3630	
643	Sháhgarh	7	24 19 10	79 7 20	33 5	„ 1 40	0·3615	
644	Khargapur	8	24 48 50	79 8 50	34 55	„ 1 35	0·3575	
645	Chhatarpur	9	24 55 50	79 35 10	34 45	„ 1 40	0·3575	
646	Ajaigarh	10	24 54 10	80 15 30	34 25	„ 1 25	0·3595	
647	Amánganj	11	24 25 40	80 2 30	33 10	„ 1 30	0·3625	
566	Salaiya	4	23 51 10	79 58 20	32 40	„ 1 25	0·3620	Station of Season 1903-04.
648	Manchar	15	19 9 10	73 56 10	22 30	W 0 10	0·3760	
649	Sangamner	16	19 34 20	74 13 30	23 55	E 0 10	0·3685	
650	Shevgaon	2	19 21 20	75 14 0	23 25	„ 0 50	0·3710	
651	Shagud	7	19 22 0	75 42 40	23 25	„ 0 20	0·3725	
652	Chousálla	5	18 42 50	75 41 40	21 45	„ 0 35	0·3695	
653	Ter	6	18 19 40	76 9 10	21 5	„ 0 45	0·3735	
654	Mominabad	7	18 44 0	76 23 30	22 10	„ 0 30	0·3720	
655	Udgír	5	18 23 30	77 7 0	21 40	„ 0 55	0·3750	
656	Aurád	6	18 15 0	77 24 30	21 40	W 0 15	0·3750	
657	Bidar	7	17 55 0	77 31 0	20 35	E 0 25	0·3770	
658	Rajasoor	8	17 48 30	77 2 30	20 15	„ 0 25	0·3760	
659	Dallum	8	17 51 50	76 28 40	20 10	W 0 10	0·3705	
660	Miraigaon	9	18 44 0	75 1 20	22 0	E 0 40	0·3745	
661	Bijápur	3	16 50 0	75 43 20	18 15	„ 0 10	0·3785	
662	Gabsavalgi	4	16 58 50	76 21 0	18 10	„ 0 15	0·3760	
663	Shorápur	5	16 31 0	76 45 40	17 30	„ 0 15	0·3785	
664	Mudgal	6	16 1 10	76 27 10	16 0	„ 0 10	0·3765	
665	Gadag	7	15 25 10	75 38 10	15 25	„ 0 15	0·3755	
666	Alúr	8	15 49 30	75 39 0	16 0	„ 0 5	0·3780	
667	Alimatti	9	16 21 10	75 53 20	17 10	„ 0 5	0·3760	
668	Korkop	10	16 1 10	75 6 0	16 20	„ 0 10	0·3775	
669	Jamkhandi	11	16 30 50	75 17 10	17 15	W 0 20	0·3790	
670	Jath	10	17 2 40	75 12 0	18 40	E 0 5	0·3750	
671	Pandharpur	11	17 39 40	75 19 30	19 35	W 0 5	0·3770	
672	Náteputa	9	17 54 10	74 45 30	20 30	E 0 5	0·3720	
673	Kaledhon	10	17 26 0	74 37 40	19 45	„ 0 20	0·3740	
674	Nundy Bayoor	12	14 54 10	76 3 20	13 50	W 1 55	0·3730	
675	Tadgole	15	13 24 50	78 13 0	10 25	„ 0 25	0·3820	
676	Kuvoy	17	12 5 40	75 11 30	8 50	E 1 35	0·3810	
677	Kasaragod	1	12 30 0	74 59 40	10 30	W 1 15	0·3820	
678	Mangalore	2	12 52 0	74 49 40	9 50	„ 0 55	0·3760	
679	Udipi	2	13 20 40	74 44 20	10 40	„ 0 5	0·3765	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season 1904-05—contd.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
680	Coondapoor	13/12 3	13 37 30	74 41 40	10 55	W 0 10	0·3795	
681	Bhatkal	" 4	13 59 30	74 32 0	9 40	" 0 55	0·3750	
682	Kumta	" 5	14 26 10	74 24 50	12 0	E 0 25	0·3890	
683	Kárwár	" 6	14 47 30	74 7 20	13 40	W 0 10	0·3780	
684	Vengurla	14/12 10	15 51 30	73 37 20	15 50	0 0	0·3765	
685	Devgad	" 11	16 21 50	73 21 50	17 25	E 0 25	0·3690	
686	Ratnágiri	" 12	16 59 10	73 18 50	17 10	" 0 45	0·3775	
687	Dábhol	14/12 11	17 35 20	73 10 0	19 55	" 0 30	0·3690	
688	Bánkot	" 12	17 58 20	73 2 30	21 35	" 0 40	0·3670	
689	Revdanda	15/12 1	18 32 20	72 57 0	22 20	" 0 55	0·3695	
690	Mahuva Bandar	15/12 10	21 2 20	71 46 30	26 30	" 0 35	0·3650	
691	Jáfarabad	16/12 4	20 51 50	71 22 10	26 45	" 1 20	0·3635	
692	Balasore	18/12 4	21 30 30	86 54 40	27 55	" 1 0	0·3750	
693	Bhadrak	" 5	21 5 10	86 31 0	27 0	" 0 45	0·3780	
694	Jenapur	18/12 1	20 51 30	86 4 10	26 45	" 0 55	0·3740	
695	Cuttack	" 2	20 27 20	85 53 50	25 35	" 0 10	0·3770	
696	Puri	" 3	19 48 40	85 50 10	24 25	" 0 40	0·3805	
697	Tapang	" 4	20 3 20	85 34 50	25 5	" 0 45	0·3780	
698	Rambha	" 5	19 32 0	85 6 0	23 55	" 0 30	0·3795	
699	Berhampur (Ganjám).	12/12 1	19 18 10	84 48 40	23 25	" 0 35	0·3795	
700	Palasa	14/12 1	18 45 20	84 26 0	22 15	" 0 30	0·3805	
701	Chicacole Road	" 2	18 24 30	83 54 20	21 30	" 0 30	0·3805	
702	Vizianagram	" 3	18 6 40	83 24 0	21 55	0 0	0·3825	
703	Tuni	13/12 1	17 21 30	82 32 10	19 15	" 0 15	0·3815	
704	Cocanada (Port)	13/12 1	16 56 20	82 14 10	18 20	" 0 15	0·3805	
705	Rajahmundry	13/12 2	17 0 40	81 46 20	18 40	" 0 20	0·3820	
706	Bhimadol	13/12 2	16 48 40	81 15 30	18 0	" 0 10	0·3815	
707	Masulipatam	" 3	16 11 30	81 7 40	17 0	" 0 10	0·3805	
708	Phirangipuram	13/12 4	16 17 50	80 15 40	16 50	W 0 15	0·3840	
709	Gundlakamma	" 5	15 59 10	79 38 20	16 15	0 0	0·3815	
710	Cumbum	" 6	15 35 50	79 6 40	15 25	E 0 10	0·3780	
711	Diguvametta	14/12 5	15 23 30	78 49 20	15 10	W 0 5	0·3800	
712	Nandyal	" 6	15 28 20	78 28 0	15 30	" 0 5	0·3800	
713	Kurnool Road	" 7	15 23 20	77 52 10	15 0	E 0 5	0·3800	
714	Tándúr	14/12 9	17 15 10	77 34 40	18 45	" 0 20	0·3780	
715	Gollaguda	" 10	17 25 0	78 1 50	19 30	" 0 35	0·3760	
716	Kistnapur	" 11	17 48 0	78 44 10	20 5	" 0 15	0·3790	
717	Thaviogpully	14/12 5	18 16 40	79 6 30	21 0	" 0 45	0·3720	
718	Pedapalli	" 6	18 36 30	79 22 30	22 20	" 0 40	0·3730	
719	Asanada	" 7	18 45 30	79 44 30	22 20	" 0 30	0·3760	
720	Kottapalle	" 8	18 22 0	79 47 10	21 0	" 0 30	0·3765	
721	Lankalagada	" 9	18 41 0	80 7 10	22 0	" 0 30	0·3760	
722	Nágáram	" 10	18 20 50	80 25 40	21 15	" 0 40	0·3775	
723	Biaram	" 11	18 3 10	80 44 20	20 40	" 0 35	0·3790	
724	Burgampoi	" 12	17 38 30	80 52 10	19 35	" 0 25	0·3805	
725	Damapet	14/12 3	17 17 20	81 0 10	19 0	" 0 10	0·3805	
726	Podili	16/12 7	15 37 10	79 36 20	15 20	W 0 5	0·3810	
727	Pamur	" 8	15 5 20	79 24 40	14 25	" 0 5	0·3810	
728	Nandavaram	14/12 9	14 40 30	79 28 50	13 15	0 0	0·3820	
729	Badvel	" 10	14 44 0	79 3 50	13 30	W 0 10	0·3815	
730	Chyágalamarri	14/12 16	14 56 40	78 35 20	13 50	" 0 10	0·3815	
731	Kurnool City	14/12 8	15 49 50	78 2 20	16 0	0 0	0·3785	
732	Kuta Kata	" 9	16 23 30	77 56 0	17 25	0 0	0·3775	
733	Rájumpett	" 10	16 51 40	78 9 40	18 25	E 0 15	0·3780	
734	Shumshabad	14/12 12	17 15 30	78 23 50	19 25	W 0 5	0·3745	
735	Náráyanpur	" 13	17 9 40	78 52 40	18 55	" 0 5	0·3760	
736	Devarakonda	14/12 11	16 41 10	78 55 10	17 40	E 0 10	0·3785	
737	Vélésvaram Ferry.	16/12 9	16 28 30	79 12 40	17 25	0 0	0·3785	
738	Komaravole	15/12 10	16 6 10	79 20 0	17 15	W 0 25	0·3850	
739	Dáchépalle	" 11	16 36 0	79 43 40	17 35	E 0 10	0·3795	
740	Tipparti	16/12 13	17 0 40	79 24 50	18 25	" 0 5	0·3785	
741	Bálkonda	14/12 14	18 51 30	78 19 40	22 30	" 0 40	0·3750	
742	Jagtiyál	" 15	18 47 30	78 54 40	22 15	W 0 40	0·3765	
743	Tándúr	18/12 1	19 9 0	79 26 40	23 5	E 0 20	0·3740	
744	Sokra	" 2	19 27 40	79 4 10	23 50	" 0 10	0·3735	
745	Sirpur Tándúr	" 3	19 28 30	79 35 0	23 30	" 0 35	0·3740	
746	Chánda	" 4	19 57 50	79 17 40	24 35	" 0 45	0·3735	
747	Danura	16/12 2	19 46 50	78 45 10	25 10	" 0 50	0·3720	
748	Kupti	" 3	19 21 10	78 25 10	22 30	" 0 30	0·3730	
749	Dhánura	" 4	19 19 10	78 8 30	23 45	" 1 10	0·3760	
750	Umarkhed	" 5	19 36 10	77 41 20	24 15	" 0 35	0·3730	
751	Hingoli	" 6	19 43 30	77 9 0	24 50	" 1 10	0·3675	
752	Básim	" 7	20 6 50	77 8 20	25 35	" 2 0	0·3635	
753	Káranja	" 8	20 28 30	77 29 20	26 55	" 0 50	0·3595	
754	Goilkera	14/12 3	22 30 20	85 21 30	29 40	" 1 10	0·3715	
755	Rourkela	14/12 1	22 13 40	84 51 30	29 15	" 0 55	0·3695	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season 1904-05—concld.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
756	Bámra	42 2	22 3 30	84 17 30	29 10	E 1 10	0·3700	
757	Kankía	„ 4	21 52 30	83 44 20	28 40	„ 1 5	0·3720	
758	Kharsia	„ 3	21 59 40	83 6 20	28 50	„ 1 5	0·3705	
759	Akaltara	43 1	22 2 10	82 25 40	28 45	„ 1 5	0·3705	
760	Belghana	„ 2	22 25 50	82 2 20	28 50	„ 0 55	0·3690	
761	Khairi	„ 3	22 55 20	81 52 50	30 35	„ 1 10	0·3660	
762	Shahdol	44 1	23 17 0	81 21 50	31 5	„ 1 10	0·3675	
763	Umaria	44 12	23 31 10	80 49 10	31 30	„ 1 15	0·3645	
764	Bhátápára	44 4	21 44 0	81 56 30	28 15	„ 1 55	0·3700	
765	Raipur	„ 5	21 15 50	81 38 20	27 35	„ 1 0	0·3710	
766	Rájim	45 1	20 58 30	81 52 10	27 0	„ 0 55	0·3720	
767	Dhamtari	„ 2	20 42 40	81 32 40	26 15	„ 0 50	0·3725	
768	Ráj-Nándgaon	45 11	21 6 10	81 2 20	26 55	„ 1 0	0·3725	
769	Sálekasa	46 2	21 17 30	80 30 40	27 10	„ 0 45	0·3775	
770	Bálaghát	„ 3	21 48 40	80 12 10	28 20	„ 0 55	0·3700	
771	Nainpur	„ 4	22 25 40	80 5 40	29 40	„ 1 0	0·3680	
772	Seoni	„ 5	22 4 10	79 32 50	28 55	„ 1 0	0·3680	
773	Chhindwára	43 5	22 3 40	78 57 30	27 55	„ 1 5	0·3665	
774	Koka	44 7	21 15 30	79 43 0	27 10	„ 0 55	0·3700	
775	Kamptee	„ 8	21 12 30	79 12 40	27 15	„ 1 0	0·3680	
776	Paonár	49 9	20 46 50	78 42 40	26 0	„ 0 25	0·3710	
777	Warora	49 5	20 14 20	79 0 20	25 10	„ 0 45	0·3700	
778	Dhámangaon	49 10	20 46 50	78 8 40	25 40	„ 1 40	0·3685	
779	Amráoti	„ 11	20 55 30	77 45 50	26 45	„ 0 30	0·3655	
780	Yavlkhed	„ 12	20 42 50	77 4 30	26 5	„ 0 35	0·3695	
781	Nándúra	49 8	20 50 20	76 28 30	25 25	„ 0 55	0·3725	
782	Chanree	49 13	23 12 40	80 30 0	32 5	„ 1 15	0·3635	
783	Kasaisonda	„ 14	23 4 40	80 54 0	...	W 8 45	0·3520	The first station was on rock markedly magnetic, the second was about ½ mile distant.
783 (a)	Kasaisonda (a)	„ 14	23 4 50	80 53 50	30 50	E 1 50	0·3650	
784	Dindori	43 6	22 57 0	81 4 10	29 35	„ 1 25	0·3670	
785	Mudhopur	„ 7	22 45 40	81 25 20	30 15	„ 1 5	0·3640	
786	Bamtara	„ 8	21 43 0	81 31 40	28 20	„ 0 55	0·3700	
787	Kawurda	„ 9	22 0 20	81 13 40	28 55	„ 1 15	0·3680	
788	Rajadhar	„ 10	22 14 0	81 2 40	29 10	„ 1 10	0·3675	
789	Thonda	43 9	22 27 50	80 38 30	29 45	„ 0 55	0·3670	
790	Kakaria	„ 10	22 48 10	80 15 10	30 5	„ 0 55	0·3670	
791	Lakhnádon	„ 11	22 36 10	79 36 30	29 35	„ 1 0	0·3670	
792	Deolapur	„ 6	21 35 10	79 22 20	27 50	„ 0 55	0·3700	
793	Deonawa	43 6	21 52 0	78 29 30	28 35	„ 0 40	0·3675	
794	Betúl	„ 7	21 54 50	77 53 40	28 25	„ 1 0	0·3665	
795	Palsia	„ 8	21 45 20	77 31 0	28 15	„ 0 45	0·3540	
796	Rangubáli	„ 9	21 42 40	77 8 20	27 30	„ 0 55	0·3675	
797	Darni	43 12	21 32 40	76 53 10	25 50	„ 0 5	0·3785	
798	Jiri	„ 13	21 10 40	76 50 50	28 0	„ 1 0	0·3705	
799	Anjangaon	43 10	21 10 40	77 18 30	27 15	„ 0 50	0·3715	
800	Brahmanwára	„ 11	21 19 20	77 44 20	28 5	„ 0 40	0·3680	
801	Loni	„ 12	21 23 0	78 12 10	27 35	„ 0 55	0·3685	
802	Kátol	„ 13	21 16 0	78 35 50	27 35	„ 1 5	0·3700	
803	Umrer	43 6	20 51 0	79 20 0	27 0	„ 1 20	0·3695	
804	Dotai-Surandeo	„ 7	20 46 0	79 48 0	26 20	„ 1 0	0·3715	
805	Palasgarh	„ 8	20 39 0	80 17 10	26 15	„ 0 50	0·3715	
806	Kosemi	„ 9	20 23 40	80 34 10	25 35	„ 0 55	0·3725	
807	Dankasa	„ 10	20 20 30	80 56 10	25 20	„ 0 40	0·3735	
808	Kánker	49 3	20 16 10	81 29 50	25 20	„ 0 40	0·3750	

Repeat Stations.

XVI	Bhusával	...	21 2 46	75 47 18	26 40	E 1 0	0·3685	
XVII	Jubbulpore	...	23 8 57	79 56 44	30 40	„ 1 10	0·3650	
XIII	Darjeeling	...	26 59 49	88 16 39	38 10	„ 1 50	0·3565	
XVIII	Tavoy	...	14 4 50	98 12 30	12 25	„ 0 45	0·3940	
XIX	Lashio	...	22 56 47	97 44 40	31 15	„ 1 0	0·3760	
XX	Akyab	...	20 7 53	92 53 18	25 25	„ 1 0	0·3820	
XXI	Silchar or Cáchár.	...	24 49 43	92 47 21	34 35	„ 1 25	0·3685	
XXII	Dibrugarh	...	27 29 24	94 55 40	39 20	„ 1 30	0·3580	
VII	Bangalore	...	12 59 35	77 35 58	9 30	W 0 25	0·3815	

NOTE.—The above values of Dip, Declination and Horizontal Force are uncorrected for secular change, diurnal variation, instrumental differences, etc., and are to be considered as preliminary values only.

Where blanks occur, values have been already found during previous field seasons, or the observations have not been completed.

The Survey numbers refer to the published chart: thus No. 43 3 denotes No. 3 station in the dotted square, the spherical co-ordinates of whose centre are 26° North Latitude and 76° East Longitude.

All Longitudes are referable to that of Madras Observatory taken at the value, 80°-14′-49″ East from Greenwich.

Reg. No. 543-S. 05

TABULAR STATEMENTS.

Summary of the outturn of work of the

Scale of survey. Inches=1 mile.	Number of Party.	*Locale* of Operations.		Triangulation. Instrument used. Diameter in inches.	Area in square miles.	Square miles to each point trigonometrically fixed.	Square miles to each height.	1st Class. Stations fixed.	1st Class. Triangular error in seconds.	1st Class. Error per mile in feet.	Secondary. Stations fixed.	Secondary. Triangular error in seconds.	Secondary. Error per mile in feet.	Tertiary. Intersected points.	Tertiary. Error per mile in feet.	Spirit-levelling Operations. Miles levelled over.	Permanent bench-marks emplaced.	Trigonometrical stations connected with.
105·6	Detachment.	Calcutta	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
64	8	Muttra City	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Brindaban City	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Moradabad City	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
			5	...	...	...	...	...	...	...	..	...	..	...	...	...	...	...
52·8	7	Rangoon Town	...	...	...	...	...	...	...	...	—	...	...	...	...	...	...	...
64 & 16	15	Cantonment surveys	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
32	Detachment.	Calcutta Suburbs survey	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
16	8	Moradabad	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Bánda	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Hamírpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	7	Burma, Pakôkku	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	4	Bengal, Bhágalpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Purnea	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	5	„ Ranchi	15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Midnapore	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Singhbhum	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	6	„ Faridpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Backergunge	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Assam, Nowgong (Tea Grants).	20	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Sibságar (Tea Grants).	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Lakhimpur. Tea Grants.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Lakhimpur. Villages	...	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	1	Central Provinces—Chánda and Hoshangabad.	..	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Provi. Surveys.	Miscellaneous	25	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
			...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
12	12	Sind	.	6	..	...	...	...	...	...	.	...	...	...	...	...	...	...
8	17	Bombay Forests	...	...	...	..	...	...	...	...	...	...	...	...	...	...	...	...
6	18	Kohát (Khushálgarh)	...	7	175	·32	·32	...	...	...	38	16	2·97	360	4·6	...	...	...
4	4	Bengal, Bhágalpur	30	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Purnea	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	5	„ Backergunge	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Bengal, Kodarma Estate	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Angul	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	9	Assam, Nowgong	...	5	55	1·4	1·4	...	...	...	11	14·1	0·01	27	0·02	...	...	...
		„ Gáro Hills	35	6	389	6·0	6·0	...	...	...	26	22	1·5	35	1·8	...	...	...
		„ Kámrúp	...	2	878	9·75	9·75	...	...	...	34	26	0·75	21	1·65	...	...	...
		„ Darrang	...	5 & 6	285	3·5	3·5	...	...	...	25	18	0·8	49	1·3	...	...	...
		„ Sibságar	...	7	206	5·1·5	5·1·5	...	...	...	2	12	2·1	...	...	...	...	...
			...	6	120	...	...	...	...	...	4	...	...	...	...	...	...	...
		Carried over	40	...	1933	...	...	...	..	...	...	...	...	...	...	...	...	...
			...	...	2108	...	...	...	...	...	...	...	...	...	...	...	...	...

field parties during the year 1904-05.

TRAVERSING.						DETAIL SURVEY.					RECORD-WRITING.			REMARKS.
	Area in square miles.	Linear miles of new chaining.	Number of stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error per mile.	Area in square miles.	Plane-table fixings per square mile.	Linear miles of test lines.	Villages.	Average size of fields.	Area in square miles.	Villages.	Fields.	
...	...	...	...	...	...	2	...	...	...	0·17	2	...	8,352	(a) Total area of survey. Includes areas surveyed before commencement of year.
...	...	...	...	...	...	2·9(a)	...	...	...	0·09	...	...	...	
...	...	...	...	...	...	1·2(a)	...	...	...	0·12	...	...	...	
...	...	...	...	...	...	1·64	...	...	...	...	...	...	...	
5	...	...	...	...	...	5·74	...	...	...	...	...	...	...	
...	9·3	196	3,459	7	4·0	9·3	...	...	...	0·26	...	...	22,071	
...	...	...	...	...	...	25	...	...	...	...	...	...	...	
...	·3	90	2,222	...	...	3	...	...	...	0·91	3	...	2,286	
...	323	1,029	5,560	3·2	0·9	669	...	2936	807	0·78	894	1,139	5,47,308	
10	...	...	...	...	...	720	...	3118	309	0·95	755	309	4,87,457	
...	...	...	...	...	...	782	...	3577	300	1·88	782	300	2,76,338	
...	747	1,705	12,555	1·8	0·9	645	...	1546	496	1·50	...	...	1,90,046	
...	1,250	5,250	34,132	...	...	24	...	56	27	2·23	24	27	6,873	
...	468	2,447	16,195	...	...	1,748	...	8564	2,147	0·76	1,748	2,148	14,67,554	
15	1,632	4,171	30,350	...	...	909	...	2954	448	1·35	1,040	541	4,93,626	
...	...	...	...	...	...	27	...	105	56	0·37	149	441	2,57,492	
...	...	...	...	...	...	594	...	2043	917	1·14	594	917	3,31,783	
...	1,893	8,057	54,677	...	...	...	...	...	...	...	...	...	...	
...	27	122	788	...	...	1,168	...	4852	986	0·87	950	975	7,00,327	
20	1	8	75	...	...	...	...	...	...	...	...	...	...	
...	7	14	250	...	...	...	...	...	...	...	...	...	...	
...	51	9	2,002	...	...	..	...	...	...	...	...	...	...	
...	20	128	763	...	...	...	...	...	...	...	...	...	...	
...	32	111	897	3·6	0·7	...	...	...	...	...	...	...	...	
25	...	...	...	...	...	6	...	...	...	...	...	...	...	
...	6,398	23,242	...	...	...	7,292	...	...	...	...	...	...	...	
...	...	127	189	2'-0"	0·3	13	...	...	...	...	...	...	...	
...	...	...	...	...	...	187	218	147	...	...	...	...	...	
...	...	...	...	...	...	137	209	145	...	...	...	...	...	
30	130	85	474	...	...	123	...	74	99	...	...	...	...	
...	234	138	836	...	...	129	...	113	61	...	...	...	...	
...	571	1,094	6,946	...	...	320	...	119	18	...	...	...	...	
...	...	...	565	8·3	3·7	...	...	...	...	...	...	...	...	
...	...	66	1,192	4	5·3	232	176	46	...	...	...	...	...	
35	...	...	2,788	11·3	4·8	108	197	...	...	...	...	...	...	
...	...	23	3,521	5·6	3·2	29	158	...	...	...	...	...	...	
...	...	53	3,001	5·0	2·0	11	195	...	...	...	...	...	...	
...	...	54	1,726	6·6	2·2	...	...	...	...	...	...	...	...	
...	...	...	756	...	...	...	...	...	...	...	...	...	...	
2	1,235	1,513	...	...	...	952	...	...	...	...	...	...	...	
	7,645	25,168	...	...	...	8,620	...	...	...	...	...	...	...	

Summary of the outturn of work of the

Scale of survey. Inches=1 mile.	Number of Party.	*Locale* of Operations.		TRIANGULATION.													SPIRIT-LEVELLING OPERATIONS.		
								1st Class.			Secondary.			Tertiary.					
				Instrument used. Diameter in inches.	Area in square miles.	Square miles to each point trigonometrically fixed.	Square miles to each height.	Stations fixed.	Triangular error in seconds.	Error per mile in feet.	Stations fixed.	Triangular error in seconds.	Error per mile in feet.	Intersected points.	Error per mile in feet.	Miles levelled over.	Permanent bench-mark stones embedded.	Trigonometrical stations connected with.
		Brought forward	...	...	1933	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4			...	...	2108	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Punjab, Lahore	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Jhelum	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Hazára	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	9	„ Khanpur	45	6	163	1·8	1·8	...	..	....	21	29	0·5	70	1·6	..	...	..	...
		Burma, Katha	...	6 & 8	602	20·6	20·6	...	...	...	12	38	0·3	...	...	...	...	...	...
		„ Mu, &c.	...	6	100	12·5	12·5	...	...	...	5	17	2·3	...	...	...	...	...	...
		Berar, Básim	...	6	496	..	...	...	...	...	38	...	...	20	..	...	...	...	...
	15	North-Western Frontier	50	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	17	Bombay Forests	50	6 & 7	1,010	0·6	0·6	...	...	...	254	17·5	0·5	1533	0·7	...	...	...	...
	19	Madras Forests—Coimbatore. Ganjam																	
		„ „ South Canara	...	6	1,022	1·1	1·1	...	...	...	73	22·2	0·5	706	1·2	...	...	...	
		„ „ Godávari.																	
		Burma Forests—Pakôkku and Upper Chindwin. Upper and Lower Chindwin. Thayetmyo. Lower Chindwin.																	
	20		...	6	800	20	21	...	...	...	11	6·9	0·3	13	0·5	...	...	...	
		Total	...	...	6,126	...	...	...	...	...	...	...	...	...	...	...	...	...	
2	1	Central Provinces	55	...	...	...	..	...	...	...	...	...	...	...	...	...	...	...	
	2	Berar	...	6	1,690	3·6	3·7	49	7·4	·11	18	11·0	0·1	362	0·45	...	...	...	
	8	United Provinces of Agra and Oudh.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	9	Assam, Darrang	...	7	206	51·5	51·5	...	...	...	2	12	2·1	...	...	...	...	...	
		„ Sibságar	...	6	120	...	...	...	...	...	4	...	...	...	...	...	...	...	
	11	North-Western Frontier	60	8 & 6	1397	1·4 / 1·6	1·4 / 1·6	...	...	...	57	6·4	0·14	398	·47 / ·17	...	...	...	
	12	Sind	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	14	United Provinces of Agra and Oudh—Fatehpur, Cawnpore and Allahabad.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	15	North-Western Frontier	...	8 & 16	2193 / 1408	157	182·1	...	...	...	14	4·5	0·1	...	...	...	...	...	
	18	Multán and Muzaffargarh	...	...	...	2·7	2·7	...	...	...	7·2	6·6	0·13	517	0·34	...	...	...	
		Total	65	...	7,074	...	...	...	...	...	...	...	...	...	...	...	...	...	
1	3	Upper Burma	...	6	1,218	9·8	10·4	...	...	...	17	7·8	0·17	107	0·74	...	...	...	
	10	„ „	...	6	3,912	..	...	...	...	...	49	(d)	(d)	(d)	(d)	...	...	...	
		Burma—China Boundary	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	12	Sind	...	...	...	...	..	...	...	...	...	...	...	...	...	...	...	...	
		Total	70	...	5,130	...	...	...	...	...	...	...	...	...	...	...	...	...	
½	12	Sind	...	6	7,775	12	12	...	...	...	60	7·2	0·16	560	0·27	...	...	...	
		Somaliland Field Force	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
½		Seistan Mission	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	10	Upper Burma	...	6	1,950	39	...	...	...	...	10	25	60	39	...	...	...	...	
		Burma—China Boundary	75	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Somaliland Field Force	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
		Tibet	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	25	Tidal and Levelling	...	...	...	...	...	...	...	...	...	...	...	...	...	318	31		
		GRAND TOTAL	79	...	28,230	...	...	...	...	...	...	...	...	...	...	...			

field parties during the year 1904-05.

TRAVERSING.						DETAIL SURVEY.					RECORD-WRITING.			REMARKS.
	Area in square miles.	Linear miles of new chaining.	Number of stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error per mile.	Area in square *miles*.	Plane-table fixings per square mile.	Linear miles of test lines.	Villages.	Average size of fields.	Area in square miles.	Villages.	Fields.	
...	1,235	1,513	...	...	...	952	...	...	...	...	...	...	...	
...	7,645	25,168	...	...	...	8,620	...	...	...	...	...	...	...	
...	...	...	...	...	...	60	113	12	...	...	...	...	...	(*b*) Plane-table fixings.
...	...	...	...	...	...	46	130	...	...	...	...	...	...	
45	...	...	...	...	...	156	170	2	...	...	...	...	...	(*c*) Supplementary survey.
...	...	...	...	...	...	...	...	...	...	...	...	...	...	(*d*) Triangulation computations not completed.
...	...	256	5,294	5·5	5·7	234	170	147	...	...	...	...	...	(*e*) Includes 1052 square miles triangulated in 1903-04, but computed in 1904-05.
...	...	284	5,028	2·4	3·0	267	185	156	...	...	...	...	...	(*f*) Includes 708 miles traversed in 1903-04, but computed in 1904-05.
...	...	...	2,939	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	75	...	77	...	...	...	...	...	
...	...	23	126	...	...	597	113	311	...	...	...	...	...	
						134	37	225	...	...	...	...	...	
						135	185	244	...	...	...	...	...	
...	...	29	738	0·09	...	254	139	212	...	...	...	...	...	
						227	101	169	...	...	...	...	...	
						203	171	4	...	...	...	...	...	
...	...	976	16,135	3·99	2·82	277	171	150	...	...	...	...	...	
						108	171	57	...	...	...	...	...	
						92	171	107	...	...	...	...	...	
...	1,235	3,081 (*f*)	...	...	...	3,817	...	...	...	...	...	...	...	
55	...	...	...	...	...	2,719	13·7	655(*b*)	...	...	...	...	...	
...	...	...	...	...	...	483	18	306	...	...	...	...	...	
...	...	...	...	...	...	167	...	...	...	...	...	...	...	
...	...	185	1,726	8·6	2·2	...	...	...	...	...	...	...	...	
...	...	107	756	...	...	...	...	...	...	...	...	...	...	
60	...	...	...	...	...	982(3)	...	...	...	...	...	...	...	
...	...	...	...	...	...	2,787	13	770	...	...	...	...	...	
...	...	...	...	...	...	2,426	...	664	...	...	...	...	...	
...	...	...	...	...	...	1,509(4)	...	325	...	...	...	...	...	
...	...	4,547	10,969	5	0·3	1,511(4)	9·5	227	...	...	...	...	...	
65	...	4,839	...	...	...	12,584	...	...	...	...	...	...	...	
...	...	53	...	...	...	2,078	4·8	39	...	...	...	...	...	
						425(*c*)	15·8(*d*)	38(*e*)	...	...	...	...	...	
...	...	...	...	...	...	3,940	7	1,031	...	...	...	...	...	
...	...	...	...	...	...	1,070	...	...	...	...	...	...	...	
...	...	...	...	...	...	1,150	3	180	...	...	...	...	...	
70	...	...	...	...	...	8,663	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	1,253	...	...	...	...	...	...	...	
...	...	...	...	...	...	27,000	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	
75	...	...	...	...	...	2,970	...	...	...	...	...	...	...	
...	...	...	...	...	...	17,687	...	...	...	...	...	...	...	
...	...	...	...	...	...	40,000	...	...	...	...	...	...	...	
	...	...	...	...	...	...	...	...	...	...	...	...	...	
	7,645	31,628	...	...	...	21,588	...	...	...	...	...	...	...	

Statement showing the cost-rates of work executed

Number of Party.	Nature and *locale* of field operations.	Cost-rate per square mile.										
		Tri-angulation.	Traversing.	Detail survey and preparation of maps on scales of								
				1″	2″	4″	6″	8″	16″	48″ & 12″	100′=1	64″
		R	R	R	R	R	R	R	R	R	R	R
	Topographical Surveys.											
1	Central Provinces	...	...	...	18·4(*b*)	...	...	...	...	...	...	...
3	Upper Burma	24·9	...	...	23·9 (*d*) 18·0	...	...	...	...	...	...	...
Bengal Surveys	Bhágalpur	...	6·5	...	...	17·9	...	...	...	...	...	...
	Purnea	...	4·5	...	...	17·6	...	...	...	...	...	...
	Backergunge	...	37·0	...	...	33·5	...	...	...	...	...	...
10	Upper Burma	6·9	...	16·9	...	...	...	...	...	...	...	...
11	North-West Frontier	24·5	...	...	64·5	...	...	...	...	...	...	...
12	Sind	3·7	...	6·9	13·9	...	...	...	...	507·2(*g*)	...	...
15	North-West Frontier	5·1 / 19·2 / 11·5	...	...	61·3	107·5	...	...	853·2	...	...	8190·5
18	Punjab	...	3·9	...	11·6(*b*)	...	...	...	...	...	...	...
	Forest Surveys.											
9	Central Provinces (Básim Berar)	3·5	4·1(*i*)	...	...	...	...	...	...	...	...	...
	Bengal (Angul)	19·3	32·2(*i*)	...	...	76·7	...	...	...	...	...	...
	„ (Kodarma Estate)	...	15·0(*i*)	...	...	...	...	...	...	...	...	...
	Assam (Sibságar, Gáro Hills, Nowgong, Darrang and Kámrúp.)	5·2	26·6(*i*)	...	...	85·5	...	...	...	...	...	...
	Punjab	...	...	...	...	24·6	...	...	...	...	...	...
	Burma (Katha, Mu, Mandalay, and Ruby Mines.)	8·6	19·9(*i*)	...	...	91·4	...	...	...	...	...	...
17	Bombay	11·7	13·2(*i*)	...	...	59·9	...	139·2	...	...	...	...
19	Madras	14·0	30·6(*i*)	...	...	123·3	...	...	...	...	...	...
20	Burma	7·7	43·9(*i*)	...	...	140·8	...	...	...	...	...	...
	Cadastral Surveys.											
4	Bhágalpur	...	31·7	...	...	...	...	...	85·4	...	...	...
	Purnea	...	47·8	...	...	...	...	...	73·5	...	...	...
5	Ranchi	...	29·5	...	...	...	...	...	51·5	...	...	...
	Midnapore	...	...	...	...	...	...	...	207·3	...	...	...
	Singhbhum	...	...	...	...	...	...	...	47·2	...	...	...
6	Faridpur	...	45·4	...	...	...	...	...	...	...	...	...
	Backergunge	...	43·4	...	...	...	...	...	108·7	...	...	...
7	Pakkóku	...	48·0	...	...	...	...	...	113·5	...	...	...
	Rangoon Town	...	2064·3	...	...	...	...	...	...	...	3887	...
8	Moradabad	...	23·8	...	...	...	...	...	40·4(*n*)	...	...	...
	Bánda	...	...	...	...	...	...	...	25·6(*h*)	...	...	...
	Hamírpur	...	...	...	...	...	...	...	29·8(*h*)	...	...	...
	Muttra City Survey	...	...	...	...	...	...	...	...	...	...	1,855
	Brindaban City Survey	...	...	...	...	...	...	...	...	...	...	1,576
	Moradabad „ „	...	...	...	...	...	...	...	36·3	...	...	1,2

by the field parties during the year 1904-05.

Cost-rate per acre, Cadastral Survey, including traversing detail survey, and mapping.	Cost-rate per square mile.			Total cost inclusive of charges for instruments to Provincial Governments.	Remarks.
	Stone embedding.	Records (*Khanapuri*).	Completion of vernacular records, assessment statistics, etc.		
R a. p.					
...	...	...	...	59,644(*c*)	
...	...	...	...	89,963	(*b*) Supplementary survey including preparation of field sections and fair mapping.
...	...	...	...		(*c*) Includes R3,991 expended on traverse charts, district maps, and arrears of computations.
...	...	...	...	(*c*)	(*d*) Supplementary survey.
...	...	...	...		(*e*) On 12-inch scale.
...	...	...	...	106,311	(*h*) Includes R35,880 spent on riverain surveys for the Local Government, R35,471 on special surveys for military purposes and R18,375 on arrears of mapping.
...	...	...	...	97,527	(*g*) Cost included under head Cadastral Survey.
...	...	...	...	78,718	(*i*) Rate per linear mile.
...	...	...	...	173,251	(*j*) Includes R1,524 cost of 4-inch boundary survey.
...	...	...	...	128,196(*h*)	(*k*) Includes 3,598 expended on arrears of mapping.
					(*l*) Includes R700 publication charges and R6,000 purchase of elephants.
					(*m*) Includes both map correction and survey based on new traversing.
					(*n*) Includes R3,146 for bringing up records in Sagaing and Shwebo and also R3,318 for traverse charts of Burma.
...	...	...	...	3,019	(*o*) Expenditure met from Provincial budget or by municipality concerned.
...	...	...	...	20,979	(*p*) Map correction based on old traverse stations.
...	...	...	...	2,156	(*q*) Includes R12,670 expended on Trans-Frontier work.
...	...	...	...	30,759	
...	...	...	...	6,453	
...	...	...	...	62,616	
...	...	...	...	77,568(*k*)	
...	...	...	...	107,642	
...	...	...	...	151,677(*l*)	
...	...	...	28·5	43,204	
...	...	...	35·6	214,226	
...	...	...	30·6	148,034	
...	...	...	104·1	21,111	
...	...	...	32·6	47,342	
...	...	...	...	85,983	
...	...	...	36·7	162,951	
...	1·0	...	...	131,057(*m*)	
...	...	...	...	65,539	
0 1 7(*n*)	2 2	...	...	51,460(*o*)	
0 0 6(*p*)	...	17·9	...	31,632(*o*)	
0 0 7(*h*)	...	17·5	...	38,787(*o*)	
2 14 5	...	19·8	...	5,306(*o*)	
2 7 5	...	...	...	1,844(*o*)	
...	...	...	...	2,931(*o*)	

Statement showing cost of Scientific Parties Survey of India for Survey Year 1904-05.

Number of Party.	Name of Party.	Nature of Scientific Work.								Total Cost of Party.	Remarks.
		Astronomical determinations.	Principal Triangulation.	Determinations of Gravity.	Tidal observations.	Preparation of Tide Tables.	Levelling Operations.	Magnetic Observations.	Magnetic field work.		
22	Astronomical	14,393	...	...	...	...	...	...	...	14,393	
23	Pendulum	...	...	35,708	...	...	...	...	...	35,708	
24	Triangulation	...	60,704	...	...	...	...	...	...	60,704	
25	Tidal and Levelling	...	...	...	15,099	24,840	25,829	...	...	65,768	
26	Magnetic	...	...	...	...	...	...	9,560	55,640	65,200	
	Total	14,393	60,704	35,708	15,099	24,840	25,829	9,560	55,640	241,773	

APPENDIX.

Report on Survey Operations with the Somaliland Field Force by Captain G. A. Beazeley, R.E.

Orders were received by Captain Beazeley to assemble a survey detachment for Somaliland at the end of December 1902. The party arrived at Obbia on 29th January 1904 and work was closed about the middle of June 1904.

Personnel.

Captain G. A. Beazeley, R.E., Deputy Superintendent, 2nd grade, in charge.
Captain C. G. W. Hunter, R.E. (joined as Assistant Survey Officer on 8th October 1903).
3 Surveyors, 40 *Khalasis* (10 of whom joined on 7th October 1903).

The work was heavily handicapped at the outset by lack of transport and facilities for extending the survey on either side of the line of communications, and with the exception of the survey of the latter very little work could be turned out till Berbera was reached in July. The work with the Obbia column was carried out under very trying conditions as the marches were made in the heat of the day under a very powerful sun and water was often very limited. From September 1903 onwards, the party was employed to its utmost capacity except when delayed by the want of an escort when work had at times to be curtailed and even stopped, though a sufficiency of transport was always available. Had an assistant officer been available from the beginning, the whole of the work accomplished in British Somaliland with the exception of the country mapped during the Nogal and Northern Somaliland expeditions, could have been completed by the time Captain Beazeley arrived at Bohodle in May 1903, and this would have set the party free to survey fresh ground during the lull in the operations pending despatch of the force into the Nogal valley.

The different surveys carried out were as follows:—

(1) Large scale survey of Obbia.
(2) Obbia-Dibit triangulation and survey.
(3) Route survey, Dibit-Galkayu.
(4) Large scale survey of Galkayu.
(5) Triangulation started at Galkayu.
(6) Route survey Galkayu-Galadi.
(7) Large scale survey of Galadi.
(8) Route survey Galkayu-Bohodle.
(9) Observations for latitude and longitude at Bohodle.
(10) Route survey Burao-Upper Sheikh.
(11) Triangulation Berbera-Eildab with branch to Lasdureh.
(12) Large scale survey of Berbera.
(13) Surveys on various scales between Berbera and Eildab based on points fixed by triangulation.
(14) Reconnaissance surveys in the Nogal and north-eastern Somaliland.

Obbia Survey.—This was on the 12-inch scale, at the request of the Camp Commandant; to show the various camps, the landing place, water-supply, and native town, etc; it was carried out while preparations were made to push the survey on to Dibit.

Obbia-Dibit Survey.—A chain of triangulation 57 miles long and survey based on it was commenced on the 11th February and completed on the 25th. A persistent strong sea breeze and driving sand rendered work almost impossible at Obbia. The breeze continued through the night, and it always clouded over so that it was impossible to obtain more than an approximate latitude and azimuth. The longitude was obtained from the naval authorities. The area surveyed was 1,225 square miles, all on the ½-inch scale. The country was open and undulating with no marked features except sandhills and a maritime ridge of hills running parallel to the coast a few miles inland, rising to the west of Obbia to nearly 1,000 feet above sea level.

The route survey, Dibit-Galkayu, scale 1 inch = 1 mile—Was commenced on the 27th February 1903, and completed on the 3rd March, the distance being about 94 miles. The country was too flat to admit of triangulation and work was entirely carried out by plane-table traverse, distances being measured by the measuring wheel. The column marched in the middle of the day under a very powerful sun with a limited supply of water, and the march was a most trying one. The country was level with occasional patches of thick low thorn bush, but open otherwise, no hills except a few isolated knolls.

Galkayu Survey.—As the survey party were not allowed to leave Galkayu while the force was halted there, there was ample time to make a large scale survey of the post and its surroundings, and this was carried out on the 6-inch scale. A remarkable feature of the place was the Yamis chasm, a big bell-shaped water hole, with domed top that had partly fallen in, and vertical sides, the water being 160 feet below the level of the top. The

water was very deep towards the west and disappeared underground by a tunnel of unknown depth, quite inaccessible except by rope.

The Galkayu Triangulation—Was started while halted at Galkayu but had to be abandoned owing to lack of transport and other causes. A short base was measured, latitude and azimuth observed and 8 stations were observed from.

Route survey, Galkayu-Galadi.—This was commenced on the 26th March and completed on the 31st. The distance is 83 miles. The work was done on the 1-inch scale by plane-table traverse, except the last portion between Dudub and Galadi, where, as time was limited, the bush was thick and the open part was covered at night, the prismatic compass was used.

The thick high bush between Bera and Gondu rendered a plane-table traverse a most arduous task as no lagging behind was allowed. The country is level and devoid of any natural features. No theodolite could be taken but one was subsequently sent up before the party returned to Galkayu. As only one camel was allowed for everything including six days' rations, only five men could be taken. Halts were made during the heat of the day to rest the troops.

Galadi Survey.—In order to fully occupy the time spent at Galadi, Captain Beazeley carried out a survey of the 2,500 wells there on the 12-inch scale. These wells were for the most part crowded into a space of about half a square mile, the whole number lying within an area of about one square mile, thus showing what an important place Galadi was, and what a large population it must have supported. As a rule the wells held very little water which trickled through very slowly. A good many of them had been poisoned by corpses. All the depths were measured and recorded, none of them reached 70 feet in depth, the average being 16 feet. Most of the trees round the wells had been cut down and the white gypsum soil was very trying to the eyes. The place was surrounded by dense high bush. A 1-inch plane-table traverse was run to Yegallo, 5 miles to the north. The survey of Galadi could not be completed as all hands were required to assist in strengthening the defences of the place after the reverse at Gumburu, but 2,250 out of the 2,500 wells were cut in. The party left on 23rd April.

The Galkayu-Bohodle route survey—Was executed on the ½-inch scale by prismatic compass traverse; time did not permit of a plane-table traverse being carried out, moreover the bush was too thick. Work commenced on the afternoon of 29th April, and was completed on the morning of 7th May. Captain Beazeley was put in charge of the small column. The distance traversed was about 147 miles. The country is level and mostly covered with dense bush except near Galkayu. The ground undulating near Badwein. A small hill was passed at Elbahai and a distinct ridge was passed at Damot. Two or three well-marked dry watercourses were passed on the march.

Operations at Bohodle.—While the party were halted at Bohodle between the 7th May and 24th June 1903, observations were carried out, when weather permitted, for latitude by circum-meridonal observations to 16 pairs of N. and S. stars and the longitude was fixed by 3 sets of 20 telegraphic signals between Berbera and Bohodle, the naval authorities at the former post kindly assisting. Preparations were made to start a triangulation from Bohodle, and elevated stations to overlook the surrounding forest and bush were built, but the presence of bodies of the enemy put a stop to further progress, Captain Beazeley's squad having a narrow escape once. The party left for Berbera on 24th June 1903.

Route survey, Burao-Sheikh.—Major Craster, R.E., had made a route survey from Berbera-Bohodle and this was partly incorporated subsequently in the fair mapping of Somaliland, but a route survey by prismatic compass was carried out from Burao-Sheikh to enable Burao, which lies in the centre of a large plain south of the Golis range, to be cut in when running a triangulation down that way. The traverse was subsequently plotted on the ½-inch scale.

Berbera-Eildab Triangulation.—The party reached Berbera on 11th July 1903. After leaving Bohodle, and after refitting, the triangulation was first carried as far as Sheikh, then extended eastward to the Wagger mountains and a temporary base measured at Sheikh. A further extension eastward was then attempted but abandoned owing to lack of men, and the party proceeded south *via* Burao, and finally carried the triangulation as far as Kerrit where a small base was measured. The party then returned to Sheikh and arrived there 15th October. The party was then reorganized and strengthened by the addition of Captain Hunter and some *khalasis* and porter coolies, and the triangulation was extended from Kerrit to Eildab, when further triangulation was stopped by order of the General Officer Commanding. After the Nogal expedition, a base was measured at Berbera and the triangulation was extended eastwards from there to the hills surrounding Lasdureh. Further triangulation was then stopped owing to the breaking up of the Field Force in May and June 1904. The area of triangulation accomplished was 14,426 square miles and consisted of 75 stations and about 150 points.

Berbera Survey.—At the request of Major Craster, R.E., a large scale survey was made of Berbera for his railway reconnaissance, it was carried out on the 6-inch scale during September and October 1903.

Surveys between Berbera and Eildab based on the triangulation.—1,396 square miles of country round Sheikh were surveyed on the $\frac{1}{125,000}$ scale (approximately 1 inch to 2 miles); 4,218 square miles of country to the south and south-east of Berbera on the ½-inch scale; 1,253 square miles of country between Gololi and Eildab on the ½-inch scale.

More could not be accomplished owing to lack of *personnel* and sickness amongst the surveyors, and escorts could not always be supplied.

Reconnaissance surveys in the Nogal and north-east Somaliland.—An area of 6,109 square miles on the ½-inch scale was accomplished in the Nogal valley, based on plane-table traverse, and 6,135 square miles on the same scale and by the same method in north-east Somaliland. The work was most arduous and gave the party very little rest on the march and when halted. The work done in the Nogal valley was checked by astronomical latitudes but no theodolite or sextant could be spared for that carried out in north-east Somaliland.

The country traversed was utterly devoid of cultivation except a small patch round a mosque at Upper Sheikh, and no traces of any settled habitations were seen except at Burao, Upper Sheikh and the seaport towns. The entire population is *nomad* and wanders about in search of pasturage and water for their flocks.

The mountainous and hilly tracts of north and west Somaliland are suitable for a survey based on triangulation, but the rest is for the most part devoid of any marked features, except perhaps the maritime ranges on the east and south-east coasts, and traverses would have to be used to base the detail surveys on. Wells and water supplies are often at great distances apart.

Captain Hunter rendered invaluable service, he was a most zealous and indefatigable officer.

Sub-surveyors Mahomed Khan and Bhamba Ram worked very well and were most zealous, more especially the latter, who rendered great assistance at computations and in office to Captain Beazeley.

G. I. C. P. O.—No. 22 S. G.—10-10-06.—450.—G. C.

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